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Impact of Proposed Financial Assurance Requirements on Nuclear Materials Licensees

COMPLETED

Prepared by P. L. Hendrickson, M. J. Scott, M. F. Mullen,
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Prepared for
U.S. Nuclear Regulatory Commission

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ABSTRACT

The NRC is considering a possible rulemaking that would require certain nuclear materials licensees to demonstrate financial ability to clean up accidental releases of radioactive materials. The rulemaking would potentially affect approximately 16,350 NRC and Agreement State licensees. This report was prepared for NRC by the Pacific Northwest Laboratory to provide background information and analysis for the potential rulemaking. Specific topics examined in the report include: 1) characteristics of potentially affected licensees, 2) the availability and cost of various financial assurance mechanisms, 3) the financial impacts for licensees (including licensees classified as small businesses) of providing $2M of assurance per licensee and a sliding amount of assurance tied to risk, 4) the cost of administering a financial assurance rule, and 5) overall benefits and costs. Tabular information on past material licensee accidents and cleanup efforts is also included. The financial assurance mechanism that appears to be most suitable for providing the desired financial assurance is one or more newly formed captive insurance companies. Potential benefits of the rulemaking include reduced need for taxpayer-funded cleanup of accidental releases, reduced administrative time to secure such funds, and the possibility of more rapid cleanup with correspondingly reduced occupational and public exposure to radioactive materials.

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SUMMARY

STATEMENT OF THE PROBLEM

This report was prepared by the Pacific Northwest Laboratory to assist the U.S. Nuclear Regulatory Commission (NRC) in its analysis of a potential requirement that certain nuclear materials licensees provide evidence of their ability to fund the cleanup of accidental or unexpected releases of radioactive materials. NRC is concerned about the cleanup issue because several releases have occurred in recent years where the licensee either was financially unable or was unwilling to clean up the released material. The responsibility for cleanup thus fell to governmental agencies who had to use various tax-generated revenues to effect cleanup. A tabulation of such incidents is included in Appendix B.

OBJECTIVES OF THE PROPOSED RULEMAKING

NRC issued an Advanced Notice of Proposed Rulemaking (ANPRM) in June 1985 to initiate discussion of the financial assurance concern. Approximately 160 comments were received in response to the Notice. The ANPRM states that the proposed rulemaking is limited to cleanup activities for onsite and offsite property and environmental restoration of natural resources. Compensation to third parties for personal injury or property damage is not included within the scope of the ANPRM, nor are anticipated decommissioning costs. The proposed rulemaking would apply to most materials licensees who are not subject to the compensation program established by the Price-Anderson Amendments to the Atomic Energy Act. Altogether, about 16,350 licensees (circa 1984) potentially would be affected by the rulemaking. These diverse licensees would include radiopharmaceutical manufacturers, industrial radiographers, users of gauging devices, firms engaged in gas chromatography and well logging, licensees performing nuclear medicine diagnosis and radiation therapy, and licensees conducting certain fuel cycle activities such as uranium milling, UF_6 production, fuel processing and fabrication, and low-level waste disposal. Publicly owned licensees would be excluded from the proposed rulemaking because of their access to tax-generated funds to pay for cleanup activities. Motor carriers of nuclear materials subject to the Federal Highway Administration's financial responsibility requirements for carriers of hazardous cargo also would be excluded.

FINANCIAL ASSURANCE ALTERNATIVES

Two dimensions of financial assurance alternatives are considered in this report. First, various types of financial assurance mechanisms are considered. Second, different levels of financial assurance coverage are discussed.

Financial Assurance Mechanisms

The potential financial assurance mechanisms for cleanup funds identified in the ANPRM include various types of liability and property insurance, surety bonds, letters of credit, escrow accounts funded by licensees, corporate guarantees, and a financial test. In addition, captive insurance companies, purchasing and risk retention groups, and various government-administered trust funds are possible financial assurance mechanisms. The availability and benefits and costs of each of the preceding mechanisms are examined in this report. An NRC-administered trust fund analogous to the Environmental Protection Agency (EPA)-administered Superfund is an additional financial assurance option; such a fund could be funded from license fees and monetary penalties applied to licensees. Although such a trust fund is a potentially attractive financial assurance mechanism, it is not examined in this report because it would require Congressional authorization.

Levels of Financial Assurance

Three principal levels of financial assurance coverage are being considered by NRC to meet the objectives of the proposed rulemaking. The first two alternatives are analyzed in this report. The first alternative is a blanket requirement that all affected licensees obtain $2M of financial assurance coverage. The $2M figure is stated in the ANPRM as the estimated upper limit of cleanup costs for a single event. The second alternative is a risk-based sliding scale of coverage under which the required coverage is related to the potential consequences of accidental release. The risk-based sliding scale used for this report was developed for NRC by Sandia National Laboratories (SNL). The third alternative being considered by NRC is the status quo; under this alternative NRC would continue to rely on existing financial assurance mechanisms. Several Agreement States, e.g., Florida, New York, and Tennessee, currently have financial assurance requirements for their licensees. Another current resource, the EPA-administered Superfund, is potentially available for cleanup of radioactive releases from materials licensees in Agreement States and for cleanup of sites posing imminent and substantial danger in all states. Many states also have "mini-Superfunds" and emergency cleanup response teams funded from general tax revenues and taxes on industry groups.

CONSEQUENCES OF THE PROPOSED RULEMAKING

This report focuses on four categories of consequences that could result from the proposed rulemaking. The first category is the potential availability of the various financial assurance mechanisms. The second category of consequences includes the direct costs to the affected licensees, including licensees classified as small businesses, of obtaining financial assurance under the various mechanisms. The third category is the costs to NRC and the Agreement States of administering a financial assurance rule if it is adopted. The report also includes information on the potential benefits of implementing a financial assurance rule.

Availability of Financial Assurance Mechanisms

The analysis conducted for this report suggests that for many licensees the most suitable mechanism to provide financial assurance will be one or more newly-formed captive insurers. The principal advantage of this mechanism is that the needed cleanup assurance can likely be made available at significantly lower cost than through commercial property/casualty insurers, surety companies, or banks. A major reason for lower cost is that a captive owned by licensees will be in a position to realistically price the insurance product based on the licensees' specific knowledge of accident risks. Another advantage of a captive insurer is that licensees could tailor the insurance product, policy language, and terms (e.g., availability and amount of deductibles) to meet specific regulatory requirements and the interests of the member/owners.

Other financial assurance mechanisms would be available to selected licensees. Although many commercial property/casualty insurers have recently stopped writing pollution-related insurance, it appears that insurance to assure cleanup of released materials would be commercially available for certain licensees from a limited number of firms. Surety bonds and letters of credit may also be available for well-capitalized licensees. Some licensees in Agreement States with financial assurance regulations have been able to obtain bonds. However, coverage through commercial insurers, surety companies, and banks is likely to be expensive. Financial assurance based on various financial tests could probably only be met by large, well-capitalized licensees. A group formed under the Liability Risk Retention Act of 1986 would be a potentially attractive financial assurance mechanism. Unfortunately, however, groups can only be formed under the Act to provide liability coverage. Onsite property/cleanup coverage is not within the allowed coverage under the Act.

Financial Impact on Licensees

The principal focus of this report is on the incremental financial impact on licensees of obtaining cleanup assurance. Sufficient data were not available to estimate the existing cost to licensees of financial assurance. Consequently, for this report we assumed that the affected licensees have no current financial assurance coverage for cleanup of accidental releases. This assumption was a necessary simplification. Some licensees clearly have obtained financial assurance coverage, either on their own initiative or in response to an Agreement State requirement.

An important component of the financial impact analysis was estimating the cost to the licensee of the alternative financial assurance mechanisms. Costs for a hypothetical captive insurer are difficult to estimate. Such an insurer would have initial administrative startup costs, an initial capital requirement, recurring administrative costs, possible onsite inspection costs, and the cost of claims. Assuming that nearly all affected licensees elect to join a newly-formed captive, we estimate that initial capital requirements might be $20M, and that the total annual aggregate premium cost to the licensees as a group would run roughly $6M/yr before taxes or $4M/yr after taxes assuming the premiums would be a deductible expense for computing federal income tax liability. The $6M/yr figure is based on past cleanup cost information collected by

SNL plus an additional 25% for administrative costs and an assumed annual aggregate cost for onsite inspections of $2M/yr.

Cost data for financial assurance coverage with more conventional mechanisms were also not readily available. Insurers and surety companies are reluctant to give hypothetical coverage quotes. This reluctance is especially great for activities with high underwriting uncertainty such as use of radioactive materials. A small number of licensees who commented on the ANPRM included information on quotes they had obtained from their insurance carriers or brokers. This information, a telephone survey of insurance company representatives (Appendix A), and prior work conducted for the NRC and EPA provided the bases for our cost estimates. These cost estimates for the conventional financial assurance mechanisms are shown in Table S.1.

Because of limitations in the available data, we made the simplifying assumption that the costs shown in Table S.1 would be representative of typical or average costs for all licensees. In actual practice, it is highly likely that financial assurance costs/$1,000 coverage would vary to reflect such factors as the nature of the licensee's activities, licensed curie quantity, material form (e.g., sealed or unsealed sources), licensee's sales volume, number of radioactive sources, past accident history, geographic location, and half-life of the source material. For example, a licensee with 100 radioactive sources would likely pay a higher premium/$1,000 coverage than a licensee with one source because the risk of accident is greater.

The licensees' approximate total annual direct costs of providing the required coverage under the simplified cost assumptions listed in Table S.1 are summarized in Table S.2. The costs range from $5M to $1,000M/yr, depending on the type of assurance mechanism. The estimated cost of a financial test or a

TABLE S.1. Assumed Annual Cost per $1,000 Coverage for Conventional Financial Assurance Mechanisms

Mechanism	Assumed Cost/Year	
	Before Tax	After Tax
Commercial Insurance	$30/$1000 coverage	$19.80/$1000 coverage
Surety Bond	$20/$1000 coverage	$13.20/$1000 coverage
Standby Letter of Credit	$15/$1000 coverage	$9.90/$1000 coverage
Escrow Account	$50/$1000 coverage	$33.00/$1000 coverage
Financial Test/Corporate Guarantee	$300-$500/licensee	$300/licensee
Assumed Composite Mix	$20/$1000 coverage[(a)]	$13.20/$1000 coverage

(a) This figure represents the authors' estimate of the overall coverage cost to licensees assuming some use of all of the preceding mechanisms (see Section 5.1.2.1).

TABLE S.2. Summary of After-Tax Costs of Conventional Assurance Mechanisms

Mechanism	Cost of $2 Million Blanket Coverage (Millions of 1985$/Yr)	Cost of Sliding-Scale Coverage (Millions of 1985$/Yr)
Commercial Insurance	$650	$150
Surety Bond	$432	$99
Standby Letter of Credit	$320	$74
Escrow Account	$1,000	$250
Financial Test/Corporate Guarantee	$5	$5
Assumed Composite Mix	$432	$99

corporate guarantee is by far the lowest, but the analysis suggests that these financial assurance options would only be available for large licensees with sales exceeding $25M/yr. Moreover, the current NRC financial assurance policy uranium recovery facilities is to allow only a parent company passing a financial test to provide the guarantee. A guarantee provided by a licensee is not acceptable regardless of its financial status. In comparison with the costs shown in Table S.2, the approximate $4m/yr cost cited above for a newly-formed captive insurer is very attractive.

Financial Impact on Small Business

The impact of the proposed rulemaking would likely be most significant for licensees with small sales volume such as licensees considered to be small businesses by NRC for purposes of the Regulatory Flexibility Act of 1980. When a proposed rule would have a significant economic impact on a substantial number of small entities, this Act requires an analysis of how the regulatory action would affect these entities. Small licensees would be least likely to be able to pass the cost of financial assurance coverage on to their customers because their coverage cost per dollar of sales probably would be higher than for larger licensees. It is difficult to accurately estimate financial impacts for particular classes of licensees in part because of the uncertainties in the coverage cost estimates shown in Table S.1. Nevertheless, it is apparent that the proposed rulemaking, if implemented, would have a significant impact on a substantial number of small licensees. This report (Section 5.3) contains much of the information that is needed to conduct the analysis required by the Act.

Administrative Costs

Any type of financial assurance program would also create administrative costs for NRC and the Agreement States. Our best estimate is that these recurring costs would likely be $7M/yr ($1985). Initial startup costs would be higher, particularly if existing licenses need to be amended to accommodate licensees seeking lower material quantity limits and correspondingly lower financial assurance costs. Most of the cost would result from verifying that

licensees have appropriate financial assurance in place. If a single captive insurer provided coverage for all affected licensees, the $7M cost figure probably could be reduced. Some or all of the projected administrative costs could be potentially recovered by NRC and the Agreement States through license fees.

BENEFITS

There are likely to be four major benefits if a financial assurance rule were implemented. The most important benefit would be to ensure that all cleanup costs would be paid by licensees or institutions compensated by licensees rather than by states or the federal government. In recent years, governmental expenditures on the order of $1M to 4.5M/yr (Table B.5) have been required for cleanup activities resulting from actions of insolvent licensees. A second benefit would be that legislatures and regulatory agencies would not need to spend time seeking or appropriating cleanup funds if adequate financial assurance were available. It is estimated that each such incident requires at least one staff-year of administrative time. A third benefit is that cleanup could potentially occur faster with financial assurance mechanisms in place. More rapid cleanup could potentially alleviate public concerns about an accidental release more quickly, and some occupational and public health effects could be averted. Finally, the number of accidental releases of radioactive materials might be reduced if licensees with poor safety performance are unable to obtain financial assurance and hence are unable to qualify for a materials license. Moreover, if the cost of financial assurance is based on past accident history, there will be an economic incentive to minimize accidental releases and thus financial assurance costs.

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ABBREVIATIONS

AIG	American International Group
ANPRM	Advanced Notice of Proposed Rulemaking
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CGL	Comprehensive General Liability Insurance
CRCPD	Conference of Radiation Control Program Directors
DOE	U.S. Department of Energy
DRR	NRC Division of Rules and Records
EIL	Environmental Impairment Liability Insurance
EPA	U.S. Environmental Protection Agency
FR	Federal Register
GAO	U.S. General Accounting Office
IRS	U.S. Internal Revenue Service
K	thousand
LMS	Licensing Management System
M	million
NARM	Naturally Occurring or Accelerator Produced Radioactive Materials
NMSS	NRC Office of Nuclear Material Safety and Safeguards
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
PLIA	Pollution Liability Insurance Association
PNL	Pacific Northwest Laboratory
SNL	Sandia National Laboratories
SNM	Special Nuclear Material
SOI	Statistics of Income
Superfund	Hazardous Substances Superfund administered by EPA
U.S.C.	United States Code

1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) is considering whether to require certain nuclear materials licensees to demonstrate that they possess adequate financial means to pay for cleanup of accidental or unexpected releases of radioactive materials and for environmental restoration of natural resources. Currently, NRC has no financial assurance requirements applicable to these licensees.(a) An Advanced Notice of Proposed Rulemaking (ANPRM) was published in the Federal Register in June, 1985, requesting comments on the proposed action.(b) Compensation for third parties who suffer adverse health impacts and/or property damage from such releases, and authorized and predictable decommissioning costs for nuclear materials and facilities are not included within the ANPRM. If adopted, the proposed rule would apply to NRC licensees and licensees in Agreement States. This report was prepared by the Pacific Northwest Laboratory to support NRC's analysis of the proposed rulemaking.

Table 1.1 shows the categories of licensees that are under consideration for inclusion in the proposed rulemaking.(c) Facilities operated by publicly-owned licensees including the U.S. Department of Energy (DOE) and its contractors and motor carriers subject to the Federal Highway Administration's financial responsibility requirements (see Section 3.2.3) are not being considered for inclusion in the rulemaking. The estimated total number of NRC and Agreement State licensees as of 1984 that would potentially be affected is about 16,350.(d)

NRC is concerned about financial assurance because public funds may be required to achieve prompt cleanup of sites where radioactive materials have been released. Public funds could be required if the licensee is financially unable to conduct cleanup operations or if he is unwilling to conduct cleanup because of disputed responsibility. Moreover, someone other than a licensee who suffers property damage will ordinarily have no insurance coverage to pay for cleanup of radioactive materials because virtually all property insurance

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(a) Certain Agreement States, e.g., Florida, New York and Tennessee, do have existing financial assurance requirements, however (see Section 3.2.5). Agreement States are states that have entered into an agreement with NRC under the authority of Section 274 of the Atomic Energy Act to regulate byproduct and source material and small quantities of special nuclear material (SNM) within the respective states' boundaries. There are currently 28 Agreement States. The terms "byproduct material," "source material, " and "special nuclear material" are defined in 10 CFR 40.4.

(b) 50 Federal Register 23960, June 7, 1985. The next action on the proposed rulemaking is stated as "undetermined" in the most recent NRC Regulatory Agenda. 52 Federal Register 15209, April 27, 1987.

(c) All of the activities listed in Table 1.1 are in addition to the scope of NRC's existing financial protection requirements for other licensed facilities discussed in Section 3.2.1.

(d) The basis for the 16,350 estimate is discussed in Appendix C.

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TABLE 1.1. Categories of Activities Considered for Inclusion in the Proposed Rulemaking

Fuel Cycle Activities	Waste Management Activities	Other Material Licensees
Uranium milling	Low-level waste disposal sites	Radiopharmaceutical manufacturing
UF_6 production	Independent spent fuel storage facilities	Industrial radiography
Nuclear fuel fabrication	Persons storing or disposing of their own waste	Gauging devices
		Gas chromatography
		Well-logging
		Nuclear medicine diagnosis
		Radiation therapy

policies in the U.S. exclude nuclear damage.(a) Several instances have occurred in recent years where expenditure of public funds to effect cleanup has been necessary.(b) From an equity standpoint, it is appropriate that funds for cleanup activities come from the responsible licensee or someone compensated by the licensee to provide cleanup assurance. A possible but somewhat less desirable source of funds is revenue collected from all nuclear materials licensees. The least desirable or equitable source of cleanup funds is general tax revenues.

The principal focus of this report is the potential financial impacts of the proposed requirement on affected licensees, the NRC, and Agreement States. Two levels of required coverage beyond the status quo are considered. The first coverage alternative is a risk-based sliding scale of required coverage that is related to the potential magnitude of cleanup costs from accidental releases of radioactive materials for particular classes of licensees. The sliding scale of financial assurance used for this report was developed for the NRC Office of Nuclear Material Safety and Safeguards (NMSS) by Sandia National Laboratories (SNL) and is shown in Table 1.2. The scale is based on an analysis of historical contamination incidents(c) and associated cleanup

(a) NRC, The Price-Anderson Act - The Third Decade, NUREG-0957, p. F-1, December 1983.

(b) A compilation of accidents since 1979 involving materials licensees is in Appendix B. Table B.1 contains incidents where government funds were needed to conduct cleanup activities.

(c) The incidents used by SNL are a subset of the incidents tabulated in Appendix B.

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TABLE 1.2. Risk-Based Sliding Scale of Financial Assurance

Licensed Activity	Licensed Quantity (Curies) < 0.1	0.1-1	1-10	10-100	> 100
I. Research, Teaching, Experimentation, Diagnostic, and Therapeutic	$0.1M	$0.25M	$0.5M	$1.0M	$2.0M
II. Measurement, Calibration, and Irradiation	0.1	0.25	0.5	1.0	2.0
III. Manufacturing and Distribution	0.1	0.25	0.5	1.0	2.0
IV. Waste Processing, Waste Storage and Service Organizations	2.0	2.0	2.0	2.0	2.0
V. Fuel Cycle Activities	2.0	2.0	2.0	2.0	2.0

Source: Letter from R. M. Ostmeyer, SNL, to P. L. Hendrickson, PNL, November 28, 1986.

costs by category of licensee. The estimated number of NRC and Agreement State licensees that would need each level of financial assurance on the sliding scale is shown in Table 1.3.

The second financial assurance alternative is a requirement that each affected licensee provide $2M of financial assurance coverage. Although $2M is not the upper bound of potential cleanup costs for all licensees affected by the proposed rulemaking, cleanup costs for most incidents to date have been within this amount (See Tables B.1 and B.2). From a risk perspective, the $2M level of coverage is unnecessarily high for most categories of licensees. It thus provides an upper bound for financial impacts on licensees. NRC has

TABLE 1.3. Estimated Number of Licensees Needing Each Level of Sliding Scale Coverage

Amount of Required Coverage	Estimated Number of Affected Licensees	Percent of Total Affected Licensees
$0.1M	7,877	48%
$0.25M	2,764	17%
$0.5M	2,990	18%
$1.0M	879	5%
$2.0M	1,839	11%
	16,349	100%

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tentatively determined that a licensee with multiple licenses would have to provide financial assurance equal to the sum of the assurance requirements for each individual license.

The remainder of this report includes five sections and three appendices. Section 2 describes the licensees potentially affected by the rulemaking. Section 3 discusses alternative mechanisms to provide financial assurance and gives examples of existing applications of the mechanisms. Section 4 examines the market availability of the alternative financial assurance mechanisms and the estimated cost of coverage for affected licensees. Section 5, the principal analytical portion of the report, discusses the impact of the sliding scale and $2M coverage requirements on the affected licensees and the potential administrative costs for NRC and the Agreement States of a financial assurance rule. Section 6 provides potential benefits of a financial assurance rule. Appendix A includes the results of an informal telephone survey of individuals in the insurance industry regarding the availability of radioactive materials cleanup insurance. Appendix B contains information on prior accidents involving materials licensees. Finally, Appendix C discusses the methodology used in estimating numbers of NRC and Agreement State licensees by category, annual sales, and quantity of radioactive material possessed.

2.0 CHARACTERISTICS OF POTENTIALLY AFFECTED LICENSEES

The objective of this section is to describe the licensees that could be affected by the proposed rulemaking. For each category of licensees, information is included on numbers of potentially affected licensees (both NRC and Agreement State), activities of firms included in these categories, and employment and sales statistics for each category. Some of the information is used in Section 5 to evaluate the ability of licensees to pass on regulation-related costs to consumers as well as to help determine the financial impact of the proposed rulemaking on licensees, including licensees that qualify as small businesses (see Section 5.3).

The licensees potentially affected by the proposed rulemaking include licensees that handle sealed and unsealed sources and those involved in fuel cycle and waste management activities. The licensees are subject to the NRC regulations in 10 CFR Parts 30, 40, 61, 70, and 72 and to the applicable regulations in Agreement States.

For purposes of this section, the potentially affected licensees are categorized in the following manner, corresponding to the groups of licensees covered by the ANPRM:

Sealed and Unsealed Sources

- Nuclear medicine diagnosis and therapy
- Manufacturing and distribution
- Academic, research and development and other
- Instrument calibration
- Industrial radiographers
- Users of gauging devices and gas chromatography
- Pool and dry irradiators
- Well-logging

Uranium Processing

- Uranium mining, uranium milling, UF_6 production, and fuel fabrication

Waste Storage and Disposal

- Commercial low-level waste disposal, spent fuel storage facilities, and persons disposing of or storing their own radioactive wastes.

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NRC has categorized its nuclear material licensees into about 100 separate groups referred to as "program codes."[a] The categories of licensees discussed in this section correspond reasonably well with the NRC's program code categorization.

Most of the data presented in this section are summarized from a survey of NRC materials licensees performed by the NRC Division of Rules and Records (DRR) in April and July, 1983.[b] The survey did not include Agreement State licensees. All of the economic data on sales and employment consequently apply to NRC licensees only. All sales figures are shown in 1985 dollars. The total estimated number of licensees shown for each category include both NRC and Agreement State licensees.

2.1 NUCLEAR MEDICINE DIAGNOSIS AND RADIATION THERAPY

Nuclear medicine diagnosis and radiation therapy are included in NRC program codes 02110-02410 under the general heading of "medical licensees." This category includes firms using ionizing radiation for identifying and treating disease. Radionuclide diagnostic procedures are conducted at hospitals and private laboratories.

Also included in this category are installers and certain users of pacemakers (22160 and 22161), users of radiation shielding (11210), and operators of nuclear medical vans (02220). Nuclear medical vans are used to transport the radioactive materials employed in nuclear medicine to patients in small outlying hospitals.

As of 1983-1984, an estimated 6412 NRC and Agreement State licensees were included in this category. Recent sales and employment data exist for the following licensees: medical institutions (program codes 02110 and 02120), private practice (02200), teletherapy (02300), cardiac pacemakers (22160 and 22161), and other medical (02400). Estimated 1983 sales per NRC licensee in these categories were roughly $31.3M ($1985) (Table 2.1). As Table 2.1 indicates, there is a wide range of sales per licensee within this category. Private practice licensees had estimated sales of roughly $1.6M ($1985) per firm in 1985, while estimated sales per medical institution were $76.5M ($1985) in 1985. For the licensees for which recent data are available, about 21% qualify as small businesses (excluding private practice) with annual billings of $3.5M or less in 1983. Physicians in private practice are classified by NRC as small businesses if their annual billings are less than $1M. Approximately 93% of physicians in private practice qualified as small businesses in 1983. The average number of employees per licensee in 1983 was approximately 614, with medical institutions employing many more workers than private practice physicians.

(a) 50 Federal Register 20913, May 21, 1985. See Appendix C for further discussion of NRC program codes.

(b) 50 Federal Register 20914, May 21, 1985. The survey results are cited as "DRR Survey." The DRR survey is described in Appendix C, Section C.1.1.

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TABLE 2.1. Estimated Nuclear Medicine Diagnosis and Radiation Therapy Industry Statistics (1983)

Total Number of Licensees in 1983-1984: 6412

Employees/licensee: 460

Sales/licensee: $31,329,000

Employees/medical institution broad licensee: 947

Sales/medical institution broad licensee: $76,456,000

Employees/private medical practice licensee: 28

Sales/private medical practice licensee: $1,060,000

Employees/institutional pacemaker licensee: 916

Sales/institutional pacemaker licensee: $58,197,000

Source: DRR Survey.

2.2 MANUFACTURING AND DISTRIBUTION

This category of potentially affected licensees includes the NRC program code classifications of Manufacturing and Distribution (03211-03214), Nuclear Pharmacies (02500), Nuclear Laundries (03218), Low Level Waste Storage (06100), Source Material Other (11200, 11300), Source Material Shielding (11210), Source Material General License Distribution (11230), and Pacemaker Manufacturing and Distribution (22162). Manufacturing and distribution licensees are involved in diverse activities and include medical suppliers that process, package and distribute products such as radioactive surgical implants and diagnostic test kits and suppliers that process and distribute radionuclide sources for use in gamma radiography and well logging. Nuclear pharmacies possess and distribute radiopharmaceuticals to hospitals and physicians. Nuclear Laundries provide cleaning services for contaminated clothing. Source Material Other licenses are issued for the possession and use of uranium and thorium for fabrication, research and manufacture of consumer products including ceramics and glassware. Shielding licenses are issued to firms involved with radiation shielding. Source Material General Distribution licensees manufacture industrial products and devices containing depleted uranium.

As of 1983-1984, 1,219 licensees were in the manufacturing and distribution category (Table 2.2). Recent economic data on NRC licensees in this category are available for program codes 03211-03213, 03218, 11200, and 11300. Table 2.2 shows the sales and employment per NRC licensee in 1983 for all of these codes aggregated together, for codes 03211-03213 and 03218 aggregated into one group called Manufacturing and Distribution, and for codes 11200 and 11300 aggregated into another group called Source Material. Roughly 32% of the companies in this category qualified as small businesses in 1983, with $3.5M or less in annual sales.

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TABLE 2.2. Estimated Manufacturing and Distribution Industry Statistics (1983)

Total Number of Licensees in 1983-1984: 1219
Sales/licensee: $36,214,000
Employees/licensee: 422
Sales/Man&Dist licensee: $28,055,000
Employees/Man&Dist licensee: 321
Sales/Source Material licensee: $46,109,000
Employees/Source Material licensee: 574

Source: DRR Survey

2.3 ACADEMIC, RESEARCH AND DEVELOPMENT, AND OTHER

This category includes educational and research institutions and a broad range of other licensees that are difficult to categorize under any other category. Educational institutions that possess and use radionuclides for teaching, training and some research purposes are issued Academic Broad and Academic Other licenses (01100-01120). Research and Development licenses (03610-03613, 03620, 21240) are issued for use of radionuclides in research unrelated to health care or life sciences. Licensees include universities, private companies, and government agencies. Some typical uses are irradiation of substances, elemental analysis, product development, and aerospace applications. The 21240 program code covers licensees involved in academic training and research and development in nuclear fuel activities apart from fuel processing. The third group within this category, "Other," includes licenses issued for civil defense (03710), source material military munitions testing (11220), transport of source material and SNM in private carriage (25100), possession and use of critical mass material (21320), possession and use of small quantities of SNM in unsealed form for biological and chemical testing and source calibration (22110 and 22111), and SNM General License Distribution (22170).

Sales and employment data are available for licensees in the Academic group (01100) and Research and Development group (03610, 03620, and 21240) (Table 2.3). Data are also available for Civil Defense (03710) and unencapsulated SNM (22110), which are included in the category of "Other" in Table 2.3. Approximately 29% of the licensees in this category had sales of $3.5M or less in 1983 and therefore qualified as small businesses.

2.4 INSTRUMENT CALIBRATION

Instrument Calibration is composed of licenses issued for possession, leak testing, and instrument calibration of sealed sources (03220-03225), and of licenses for SNM (sealed source plutonium and uranium) used for instrument and

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TABLE 2.3. Estimated Academic, Research and Development, and Other Industry Statistics (1983)

Total Number of Licensees: 882
Sales/licensee: $37,853,000
Employees/licensee: 460
Sales/Academic licensee: $51,795,000
Employees/Academic licensee: 871
Sales/R&D licensee: $37,748,000
Employees/R&D licensee: 433
Sales/"Other" licensee: $22,464,000
Employees/"Other" licensee: 294

Source: DRR Survey.

source calibration, biological and chemical testing and other uses (22120-22151). Leak testing is the process of testing for contamination of sealed source equipment such as gauges and radiographic cameras. This is accomplished by wiping the potentially contaminated surface of the device and then analyzing the wipe for indications of radiation release. Instrument calibration involves the use of sealed sources to calibrate radiation survey and monitoring equipment.

In 1983-1984 approximately 564 licensees were categorized under instrument calibration (Table 2.4). Data on instrument calibration licensees (NRC only) exist for program codes 03220, 22120, 22140 and 22150. Approximately 28% of Instrument Calibration licensees qualified as small businesses.

2.5 INDUSTRIAL RADIOGRAPHERS

Industrial radiographers are included under NRC program codes 03310 and 03320, "Industrial Radiography Fixed Location" and "Industrial Radiography

TABLE 2.4. Estimated Instrument Calibration Industry Statistics (1983)

Total Number of Licensees in 1983-1984: 564
Sales/licensee: $36,733,000
Employees/licensee: 554

Source: DRR Survey

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Temporary Job Site." These licensees use gamma rays for the nondestructive testing of pipelines, weld joints, steel structures, boilers, aircraft parts and other high-stress alloy parts. Test laboratories frequently use other nondestructive testing techniques such as ultrasound, x-ray and acceleration radiography. The use of gamma radiation represents about 50% of the testing done by these labs.

About 25% of licensees provide testing under both field and laboratory conditions. Approximately 70% of the firms provide testing of products or spot checks for quality control. Approximately 40% of the companies in this category qualified as small businesses with annual billings of $3.5M or less in 1983 (Table 2.5).

2.6 USERS OF GAUGING DEVICES AND GAS CHROMATOGRAPHY

This category of licensees is included in the NRC's classification "Measuring Systems" (03120-03124). Licensees included in this category are primarily involved in using measuring devices that use radionuclides. Approximately 90% of radionuclide gauges are used as control devices or in quality control testing in industrial processes. Major examples of these gauges include slurry pipeline density gauges, thin film thickness gauges, and fluid level detectors. About 10% of radionuclides in this category are used in instruments that measure soil density, soil water content, or roadbed composition and thickness.

As of 1983-1984, 5119 firms were in this category (Table 2.6). Approximately 37% of the companies in this category qualified as small businesses.

TABLE 2.5. Estimated Industrial Radiographers Industry Statistics (1983)

Total Number of Licensees in 1983-1984: 1008

Employees/NRC licensee: 317

Sales/NRC licensee: $30,551,000

Sources: Centaur, DRR Survey, NRC 1986.

TABLE 2.6. Estimated Gauging Device Users and Gas Chromatography Industry Statistics (1983)

Total Number of Licensees in 1983-1984: 5119

Employees/licensee: 292

Sales/licensee: $32,459,000

Sources: Centaur, DRR Survey, NRC 1986.

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2.7 POOL AND DRY IRRADIATORS

Pool and Dry Irradiators are included in the NRC classifications "Irradiators Less Than 10,000 curies" (03510 and 03511) and "Irradiators More Than 10,000 curies" (03520 and 03521). The classifications include licensees that use Cobalt-60 and Cesium-137 to produce effects requiring high radiation levels. The principal uses of irradiators are in medical and nonmedical research that is conducted by universities, and in industrial applications such as staining glass, treating hard woods, and manufacturing semiconductor materials.

In 1979, 12 firms conducted contract irradiation operations involving receipt of products from other companies, irradiation of the products and returning them to the primary manufacturer. Irradiation generally adds only a few cents to the final manufacturing costs. Most of the treated products could not be sold without being irradiated.

As of 1983-1984, 205 licensees were in the Pool and Dry Irradiator category. The estimated sales per licensee in 1983 were roughly $59.4M ($1985) (Table 2.7). Approximately 11% of the companies in this category qualified as small businesses.

2.8 WELL-LOGGING

Well-logging licensees included in the NRC classification "Well-Logging" (03110-03113) use radionuclides for surveying oil and gas wells to obtain geological information. About 32% of the licenses are issued to firms that conduct logging for their own wells. The majority of companies in this category provide well logging as their primary service.

As of 1983-1984 about 831 firms were included in this category. The estimated sales per licensee in 1983 were roughly $15.7M ($1985) (Table 2.8). Approximately 63% of the companies in this category qualified as small businesses in 1983.

TABLE 2.7. Estimated Pool and Dry Irradiators Industry Statistics (1983)

Total Number of Licensees in 1983-1984:	205
Employees/licensee:	751
Sales/licensee:	$59,382,000

Sources: Centaur; DRR Survey; Letter from Mary Jo Seemann, NRC/NMSS, to PNL, February 5, 1986.

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TABLE 2.8. Estimated Well-Logging Industry Statistics (1983)

Total Number of Licensees in 1983-1984: 831

Employees/licensee: 170

Sales/licensee: $15,708,000

Sources: Centaur, DRR Survey, NRC 1986.

2.9 URANIUM MINING, URANIUM MILLING, UF_6 PRODUCTION, AND FUEL PROCESSING AND FABRICATION

This category includes licensees that concentrate uranium ore into U_3O_8 (i.e., milling), convert the U_3O_8 into UF_6 (i.e., conversion) and fabricate enriched UF_6 into fuel for power reactors (i.e., fabrication) (program codes 11100, 11400, 11600, 11800, 21130, 21210). Solution mining, in-situ leaching of uranium ore to extract uranium, is also included in this category (11500).

In 1985, 21 mills were available for uranium milling; however, only 4 of the mills were operating (Table 2.9). Mill owners employed only 500 man-years of labor in 1985, declining from 3615 man years in 1978. The operating U.S. uranium milling operations are in Utah and Wyoming.

In 1983-1984, four solution mining NRC licensees (program code 11500) were operating. Estimated sales per licensee in 1983 were about $3.2M ($1985) (Table 2.10). Two of the four licensees qualified as small businesses in 1983.

Separate industry statistics are not available on the conversion or fabrication aspects of uranium processing; however, the entire U.S. uranium industry has been depressed since the early 1980s. During the 1960s and 1970s, the demand for uranium was increasing due to the growth of the commercial reactor industry. This rapid growth in demand and the slow expansion of uranium production forced the price of U_3O_8 up from $13/lb in 1973 to $60/lb in 1979.(a) Many new companies were attracted to the uranium industry including several major oil companies. In the late 1970s and early 1980s, the demand for uranium decreased due to the cancellation and deferral of many nuclear power plants. Also, uranium imports began to increase due to relatively lower prices from foreign sources. As a result, many domestic uranium producers were either forced out of the industry or forced to merge with other companies. A result of these consolidations has been increased industry concentration in most uranium operations. Also, the uranium milling activities are frequently only an adjunct to parent company activities. The downturn in the domestic uranium

(a) U.S. Department of Energy, United States Uranium Mining and Milling Industry: A Comprehensive Review, DOE/S-0028, May 1984.

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TABLE 2.9. Uranium Milling Industry Statistics

Year	Number of Operating Mills	Employment (Man-Years)	Capital Expenditures (Millions of Constant 1983 dollars)
1973		1522	--
1974		1668	--
1975		2237	38
1976		2727	90
1977		3175	258
1978		3615	227
1979		3476	269
1980	22	3251	294
1981	20	2367	65
1982	14	1956	12
1983	12	1400	3
1984	8	1000	8
1985	4	500	9

Source: U.S. Energy Information Administration, Domestic Uranium, Mining and Milling Industry - 1985 Viability Assessment, DOE/EIA-0477(85), November 1986.

TABLE 2.10. Estimated Solution Mining Industry Statistics (1983)

Total Number of Licensees in 1983-1984: 4

Sales/licensee: $3,213,000

Employees/licensee: 29

Source: DRR Survey.

industry is not expected to improve in the near future. However, since the majority of the existing milling operations are owned by large diversified parent companies, they may remain in the uranium industry for the next few years.

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2.10 COMMERCIAL LOW-LEVEL WASTE DISPOSAL, INDEPENDENT SPENT FUEL STORAGE, AND PRIVATE STORAGE

Commercial waste disposal, independent spent fuel storage and private storage are included in the NRC classifications "Waste Disposal (Burial)," and "Waste Disposal Service" (program codes 03231-03235). "Fresh Fuel Storage at Reactor Sites" (23100), and "Interim Spent Fuel Storage" (23200). Firms in this category provide radioactive waste disposal sites that are frequently used by medical, research and industrial licensees and are also involved in the transportation, storage, and delivery of radioactive wastes to a burial site. Most firms will pick up the wastes, store them for a short period of time, and then transport the wastes to a burial site.

As of 1983-1984 83 licensees were included in this category. Data in this category are available for "Waste Disposal Service" (program code 03232), "Fresh Fuel Storage at Reactor Sites" (23100) and for "Waste Disposal Burial" (03231). These codes are aggregated in to one group in Table 2.11. The estimated sales per licensee in 1983 were roughly $36.7M ($1985). Approximately 29% of the companies in this category qualified as small businesses with annual billings of $3.5M or less in 1983.

TABLE 2.11. Estimated Radioactive Waste Industry Statistics (1983)

Total Number of Licensees in 1983-1984:	83
Employees/licensee:	442
Sales/licensee:	$35,652,000

Sources: DRR Survey, Centaur, NRC 1986.

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3.0 FINANCIAL ASSURANCE MECHANISMS AND EXAMPLE APPLICATIONS IN EXISTING PROGRAMS

This section discusses two topics. Section 3.1 describes various mechanisms that could potentially be used to provide financial assurance. Section 3.2 discusses existing federal and state financial assurance programs that provide example applications of the mechanisms.

3.1 MECHANISMS FOR ASSURING FINANCIAL RESPONSIBILITY

Possible mechanisms for assuring that licensees are financially capable of paying accident cleanup costs are listed below:

- insurance provided by a commercial property/casualty insurer
- insurance provided by a captive insurer
- risk retention groups/purchasing groups
- surety bonds
- standby letters of credit
- financial test/corporate guarantees
- escrow/trust accounts.

These mechanisms are described in detail in the following sections. The relative advantages and disadvantages and the potential availability of each mechanism are discussed in Section 4.

3.1.1 Insurance From Commercial Property/Casualty Insurers

In general, insurance is the system of protection that derives from an agreement by the insurer to provide the insured money or some other benefit in the event of loss or injury. Insurance provides a means of managing risk by distributing the risk among larger numbers of individuals or firms. Insurance payments are limited to the face value of the policy.

There are three broad categories of insurance: life, health, and property and casualty. Insurance to meet the objectives of the ANPRM would come from a property/casualty insurer. Three basic types of insurance coverage are available from commercial property/casualty insurers that potentially apply to accidental releases of radioactive materials: comprehensive general liability (CGL) insurance, environmental impairment liability (EIL) coverage, and conventional property insurance for an insured's property.

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3.1.1.1 Comprehensive General Liability

Liability insurance is coverage to pay money to third parties that the insured becomes legally obligated to pay. CGL policies have existed for many years. The CGL policy form most widely used as of 1985 first appeared in 1966 and was modified in 1973. Two substantially altered CGL policy forms developed by the Insurance Services Office[a] were completed and began circulating in 1986. One of the new forms retains the 1973 language that coverage is triggered by the policy in effect at the time the damage occurs. The other form provides that damage is covered by the policy in effect at the time the claim is made. The typical post-1966 form provides coverage for offsite injury and property damage incurred by third parties. Damage to property owned or occupied by the insured is excluded. Under the 1973 form, damages caused by gradual pollution releases are also excluded. Under the new 1986 CGL forms, there is an almost absolute exclusion for damages caused by pollution that occurs gradually, suddenly, and/or by accident, and an absolute exclusion for cleanup cost obligations.[b] Endorsements to standard CGL policies reinstating some pollution coverage can sometimes be negotiated with the insurance carrier.

3.1.1.2 Environmental Impairment Liability

Special EIL policies began to appear after the 1973 CGL policy form was introduced. Initially the policies focused on coverage for liability due to gradual pollution releases, an event excluded under the 1973 CGL form. More recently, coverage has expanded to include personal injury, property damage, and cleanup costs resulting from both gradual and sudden releases.[c] Onsite cleanup coverage is available less often than offsite coverage.[d] Policies are most frequently written on the pollution liability form (Form GL 0029) developed by the Insurance Services Office.

3.1.1.3 Conventional Property Insurance

Conventional commercial property insurance is designed to protect the insured's own property from damage from a multitude of causes. Policies can be written to cover onsite cleanup activities and debris removal, but normally would not apply to any offsite cleanup for which a licensee might be liable. In the case of many licensees such as medical facilities with small radiation

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(a) The Insurance Services Office, based in New York City, prepares voluntary policy forms and rate (i.e., premium) manuals for property/casualty insurance companies.

(b) Y. Kouatly, "Claims Made: The Continuing Contradictions," Best's Review Property/Casualty Insurance Edition, p. 12, March 1986. Business Insurance, p. 1, February 9, 1987.

(c) P. Hannermann, PaineWebber Risk Management, Inc., "The Insurance Marketplace: Examination of Particular Insurance Contracts," Proceedings of the Third Annual Hazardous Substances Insurance Conference, May 1986, sponsored by Executive Enterprises, Inc., New York, New York.

(d) All-Industry Research Advisory Council, Oak Brook, Illinois, Pollution Liability: The Evolution of a Difficult Market, p. 18, 1985.

sources of limited half-life, this limitation may not be a significant drawback since the licensee's premises are the most likely to be contaminated site in case of accident.

3.1.2 Insurance Provided by a Captive Insurer

A captive insurance company is a limited purpose insurer formed to provide specific levels of insurance to its owners. In stock captives, ownership is represented by shares. A mutual captive is a nonstock entity owned by its members.

Captive insurance companies can be formed by a corporate parent for its affiliated companies (a "pure captive"), by the members of a trade association (an "association captive"), and by unaffiliated companies who may or may not be in the same business (a "group captive"). As of 1986 there were approximately 2600 captive insurers serving U.S. insureds. Of these, approximately 55% were pure captives, 19% were group or association captives, and 25% were credit insurance captives.(a) Total premium income in 1986 for the 2600 captives was roughly $8.5 billion. The most common captive domicile was Bermuda followed by the Cayman Islands.(b)

3.1.3 Risk Retention Groups/Purchasing Groups

The Liability Risk Retention Act of 1986(c) provides a legislative framework for the formation of risk retention groups and purchasing groups. Risk retention groups are groups formed under the Act to provide liability insurance for their members. Each group must be licensed as a liability insurance company in one state, but is exempt from many of the licensing and regulatory requirements of other states in which it seeks to operate.

Purchasing groups are groups formed under the Act to purchase liability insurance for their members on a group basis. Purchasing groups formed under the Act are exempt from many state requirements regulating and restricting the formation and operation of such groups.

3.1.4 Surety Bonds

A surety bond is a contract between a principal and a responsible third party (the surety company) that makes the surety company responsible for the

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(a) Tillinghast/TPF&C, Darien, Connecticut, 1987 Captive Insurance Company Directory. Credit insurance captives are a cross between captives that insure only their own risks and commercial insurers providing coverage to the public. Most credit insurance captives are owned by financial institutions. Ibid.

(b) Ibid. The Tax Reform Act of 1986 has largely eliminated the prior tax advantages of choosing offshore domiciles for captives. See e.g., Susan Narod, "Offshore Captives Eye Onshore Moves," National Underwriter Property/Casualty Employee Benefits Edition, p. 24, March 2, 1987.

(c) Public Law 99-563, 15 U.S.C. 3901 et seq.

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principal's duty to fulfill an obligation to an owner (the obligee). The surety company guarantees to make available the amount stated in the bond to the obligee in the event that the principal fails to perform. Two types of surety bonds are potentially applicable to the objectives of the ANPRM. Under a financial guarantee bond, a surety company would guarantee that a specific amount of money would be available for cleanup activities if the licensee fails to fulfill its cleanup obligation. Under a performance bond, a surety company would also guarantee the availability of the amount stated in the bond, or, at its option, perform (or fund) cleanup operations itself. If the surety is forced to perform on its contractual obligation, it will ordinarily seek to recover its expenditures from the principal. Many large property and casualty insurance companies have surety departments. Some surety companies are not engaged in other businesses. Surety companies must generally be licensed by the state insurance agency in each state in which they do business.

3.1.5 Standby Letters of Credit

A standby letter of credit is an independent document constituting a promise by a bank, at the request of one of its customers, to pay a third party (the beneficiary or its designee) up to the amount of the credit if the customer fails to perform as expected. The letter is irrevocable during its stated period. A typical period is one year. The bank acts to guarantee payment, but does not expect to be required to pay. By contrast, commercial letters of credit authorize a firm to draw funds on the bank up to a certain sum. A standby letter of credit need not be backed by funds the customer has deposited with the bank. The customer normally signs a note promising to repay the bank with interest if the bank is required to pay the third party. Standby letters of credit generally go through the same credit review process as regular commercial loans. As of December 31, 1984, the 100 largest U.S. banks had $132 billion in outstanding standby letters of credit.(a)

Under a standby letter of credit, the bank's obligation to pay is conditioned only upon the proper documentation of nonperformance as specified in the letter.(b) The required documentation under a standby letter of credit is usually simpler than under a commercial letter of credit.(c) The required document could be as simple as a statement that the customer (i.e., the licensee) has failed to perform and a demand for payment.

3.1.6 Financial Tests/Corporate Guarantees

Under these mechanisms, a sufficiently well-capitalized business would guarantee the availability of funds for cleanup of radioactive materials

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(a) American Banker, p. 1, August 28, 1985.
(b) J. A. McDonald, "Understanding the Risks in Standby Letters of Credit" Commercial Lending Review, p. 34, Summer 1986.
(c) B. V. McCullough, "Introduction to Commercial and Standby Letters of Credit," Letters of Credit, American Law Institute-American Bar Association course of study materials number C146, p. 42, Philadelphia, Pennsylvania, May 1986.

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released from its own operations or those of a subsidiary. The test for sufficient capitalization would be set by NRC.

3.1.7 Escrow/Trust Accounts

Under this concept a licensee would be asked to place a sum of money or a liquid security with a responsible third party. The third party could be either a private or public institution. The money would be invested by the third party and be available in case of an accidental release of radioactive material. To be effective, an escrow account or trust fund would necessarily have to be inaccessible to a licensee's creditors. An escrow account or trust fund could potentially be established for individual licensees, classes of licensees, or all affected licensees. The issue of whether a licensee who voluntarily surrendered his license could reclaim monies paid into an account/fund would need to be studied. This type of account/fund outside the direct control of the licensee is used in several states to accumulate funds for reactor decommissioning.(a) The EPA-administered Superfund (discussed in Section 3.2.2.2) is an example of a highly aggregated trust fund designed to provide monies for cleanup of hazardous waste sites.

Conceptually, it would also be possible for NRC to set up and administer a trust fund dedicated to cleanup of accidental releases of radioactive materials. Revenue for such a fund could potentially come from license fees, monetary penalties paid by licensees, and funds appropriated by Congress. This option is not examined in this report primarily because NRC has determined that it could not implement such a trust fund without special authorizing legislation.(b)

3.2 EXISTING FEDERAL AND STATE FINANCIAL ASSURANCE PROGRAMS

This section briefly reviews existing federal and state programs designed to ensure environmental cleanup in case of pollutant releases and/or to ensure the performance of actions designed to prevent releases. None of these programs is identical to the objectives of the NRC ANPRM, but many contain elements that are applicable to the proposed rulemaking.

3.2.1 NRC Programs

NRC currently administers three financial assurance programs designed to protect public health and safety from release of radioactive materials:
1) property insurance requirements for electric utility owners of production

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(a) "Financing of Nuclear Decommissioning Costs," Public Utilities Fortnightly, p. 57, March 20, 1986.
(b) Memorandum from Guy H. Cunningham, NRC Executive Legal Director, to John G. Davis, Director NMSS, March 24, 1986.

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and utilization facilities,[a] 2) financial assurance criteria for operation of uranium mills and tailings disposition, and 3) financial assurance requirements for land disposal of radioactive waste. These programs are described below. In addition, the NRC also administers financial protection and indemnity requirements adopted under the Price-Anderson Act Amendments to the Atomic Energy Act. The Price-Anderson requirements are designed to ensure that members of the public who sustain losses from incidents at nuclear reactors are compensated rather than to provide for cleanup of released materials. Nevertheless, the program is described below to further indicate the scope of NRC's financial assurance activities. In addition to the preceding financial protection requirements, NRC has proposed new rules designed to assure the availability of sufficient funds for the decommissioning of licensed facilities that are expected to have significant decommissioning costs.[b] Acceptable financial assurance mechanisms in the proposed decommissioning regulations include surety contracts, insurance, and an externally-administered sinking fund.

3.2.1.1 Production and Utilization Facilities

The NRC requires electric utility licensees to obtain the maximum amount of commercially available insurance for onsite property damage.[c] The insurance provides funds for repair or replacement of damaged property, debris removal, and onsite decontamination.[d] Coverage is provided by two insurance pools, American Nuclear Insurers based in Farmington, Connecticut and Mutual Atomic Energy Liability Underwriters, based in Chicago, and two mutual group captives based in Bermuda, Nuclear Mutual Limited and Nuclear Electric Insurance Limited.[e]

3.2.1.2 Uranium Mills

The NRC also has financial assurance requirements for licensees who operate uranium mills. Each mill operator is required to demonstrate sufficient funding to carry out decontamination and decommissioning of the site at the conclusion of the operating life, reclamation of tailings and waste disposal areas, and long term surveillance and control.[f] Financial assurance arrangements acceptable to NRC include surety bonds, cash deposits, certificates of deposit, deposits of government securities, irrevocable letters of credit, and parent company guarantees.

(a) The terms "production facility" and "utilization facility" are defined in 10 CFR 50.2.
(b) 50 Federal Register 5600, February 11, 1985.
(c) 10 CFR 50.54(w). The amount available is currently $1.23 billion. D. Shalowitz, "Nuclear Site Protection Costly," Business Insurance, p. 32, June 1, 1987.
(d) J. D. Long, Nuclear Property Insurance: Status and Outlook, NUREG-0891, p. viii, May 1982.
(e) 49 Federal Register 44645, November 8, 1984.
(f) 10 CFR 40, Appendix A.

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3.2.1.3 Radioactive Waste Sites

The NRC financial assurance requirements for commercial operation of land radioactive waste disposal sites are at 10 CFR 61 Subpart E. Licensees must provide assurance that sufficient funds will be available for site construction, operation, closure, and stabilization. Acceptable financial assurance mechanisms include surety bonds, trust funds, and letters of credit.

3.2.1.4 Price-Anderson Act

Under the Price-Anderson Amendments to the Atomic Energy Act,[a] all owners of production and utilization facilities and other licensees identified by NRC are required to carry financial protection to protect the public from adverse consequences resulting from extraordinary nuclear occurrences. In addition, individual licensees subject to Price-Anderson can be retroactively assessed up to $5M to pay any claims stemming from an accident. Financial protection is defined as the ability to respond in damages for public liability and to meet the cost of settling damage claims.[b] Cleanup of released materials is not within the scope of required coverage, although as a practical matter, funds could be used for cleanup activities. NRC has issued regulations stating the required amounts of financial protection[c] and acceptable types of protection.[d] The regulations apply to owners of commercial reactors, plutonium processing facilities, and nuclear fuel fabrication plants. The scope of the financial protection for reactors includes transportation of nuclear fuel and radioactive material to and from a reactor site, storage of fuel at the site, operation of the reactor including discharge of radioactive effluents, and storage of radioactive waste at the reactor site.[e] NRC has discretionary authority under the Price-Anderson Amendments to extend the financial protection requirements to other material licensees, but has chosen not to do so.[f] All licensees subject to the NRC financial protection requirements in 10 CFR 140 have chosen to use liability insurance purchased through one of the insurers listed in Section 3.2.1.1 to meet the requirements. The maximum liability limit offered by American Nuclear Insurers/Mutual Atomic Energy Liability Underwriters is currently $160M.[g] With 108 operating nuclear reactors, the maximum industry liability for a reactor accident is thus $160M + (108 x $5M) or $700M. The Price-Anderson Amendments will expire August 1, 1987. Legislation that would renew and revise the Amendments is currently pending in Congress.

(a) Section 170 of the Atomic Energy Act, 42 U.S.C. 2210.
(b) 10 CFR 140.3(d).
(c) 10 CFR 140.11-140.13a.
(d) 10 CFR 140.14.
(e) NRC, The Price-Anderson Act - The Third Decade, NUREG-0957, p. I-3, December 1983.
(f) Ibid.
(g) Mutual Atomic Energy Liability Underwriters is affiliated with Mutual Atomic Energy Reinsurance Pool.

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3.2.2 EPA Programs

This section discusses two financial assurance programs administered by the Environmental Protection Agency (EPA): 1) the financial requirements under the standards for owners and operators of hazardous waste facilities and 2) the Superfund program established by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

3.2.2.1 Hazardous Waste Facilities

EPA administers financial responsibility requirements for owners and operators of hazardous waste facilities as required under Section 3004(a)(6) of the Resource Conservation and Recovery Act. After authorization by EPA, states may administer their own programs for hazardous waste facilities as long as the program requirements are at least as stringent as the EPA requirements. Insurance for both liability and closure assurance can be obtained through commercial and captive insurers provided the insurer is licensed in at least one state.(a) The financial responsibility requirements appear at 40 CFR 264 and 265, Subpart H. The regulations require that an owner or operator demonstrate liability coverage for personal injury and property damage caused by sudden and nonsudden accidental releases. Acceptable mechanisms for demonstrating coverage include a financial test, corporate guarantee, and/or liability insurance. The EPA regulations also require that the owner or operator provide assurance that funds will be available for site closure and post-closure care. Acceptable mechanisms for demonstrating closure financial responsibility include a trust fund, surety bond, letter of credit, insurance, financial test, or a corporate guarantee. The financial test is by far the most widely used mechanism, followed by the trust fund.(b) The EPA issued a notice in August, 1985, requesting comments on the availability of insurance to meet the financial responsibility requirements and on methods for EPA to address potential restrictions in the availability of coverage.(c)

(a) As of February 1987, no captives or risk retention groups were providing financial responsibility coverage under the various EPA financial assurance programs. EPA is monitoring nearly twenty efforts to establish such groups that could potentially provide coverage under EPA administered programs. The groups are in various stages of formation. Personal communication with Bob Mason, EPA, Washington, D.C., February 26, 1987.

(b) U.S. General Accounting Office (GAO), Hazardous Waste: Environmental Safeguards Jeopardized When Facilities Cease Operating, GAO/RCED-86-77, February 1986. GAO reviewed 176 closed hazardous waste facilities. The owners of about 75% of these facilities used a financial test and 7% used a trust fund.

(c) 50 Federal Register 33902, August 21, 1985. Comments received in response to the notice are summarized in EPA Office of Solid Waste (WH-562), "Summary of Comments to 50FR33902 Liability Coverage," October 1985 (hereafter cited as "EPA 1985").

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3.2.2.2 CERCLA Programs Including Superfund

Under CERCLA, EPA administers:

1. trust funds (i.e., the "Superfund") to pay for cleanup of hazardous materials that are generated from excise taxes on petroleum and feedstock chemicals, an excise tax on imported chemical derivatives, and an environmental tax based on corporate alternative taxable income[a]

2. financial responsibility requirements for vessels carrying hazardous materials in U.S. waters

3. financial responsibility requirements for owners of underground storage tanks containing petroleum products.[b]

Other activities of EPA under CERCLA include administration of the National Response Center, to which unpermitted releases of hazardous materials must be reported, development of the National Priorities List (NPL) containing sites requiring cleanup action under the Superfund, and development of the National Hazardous Substance Response Plan. CERCLA also gives EPA the authority to take action or abate any situation where it is determined that a hazardous substance might cause imminent and substantial danger.[c] Except for sites posing imminent and substantial endangerment, a hazardous waste site must be listed on the NPL to be eligible for Superfund cleanup monies.

Under its CERCLA authority, EPA may seek reimbursement of cleanup costs from responsible parties.[d] It may also order responsible parties to undertake the cleanup at their own expense.

Between 1981 and 1985, approximately $1.6 billion was collected and placed in the Superfund. Between 1987 and 1991 $8.5 billion is expected to be collected.

Under Section 101(22) of CERCLA,[e] Superfund monies are not available for cleanup of releases from facilities subject to the financial protection requirements in the Price-Anderson Act Amendments or for releases from

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(a) The funds are placed in the Hazardous Substances Superfund, commonly known as the "Superfund." The Superfund is thus an example of an externally administered (in this case by a federal agency) trust fund formed to respond to pollutant releases.
(b) EPA's proposed financial responsibility requirements for underground storage tanks are at 52 Federal Register 12786, April 17, 1987. Acceptable financial assurance mechansisms under the proposed rules include a financial test, parent company guarantees, captive insurers, and risk retention groups.
(c) 42 U.S.C. 9606.
(d) 42 U.S.C. 9607.
(e) 42 U.S.C. 9601(22).

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processing sites designated under the Uranium Mill Tailings Radiation Control Act of 1978. In September 1983, EPA announced a policy decision that sites where radioactive materials have been released by a licensee with a current NRC license would not be included on the NPL on the grounds that NRC has authority to require cleanup.(a) Sites contaminated by Agreement State licensees and facilities previously licensed by NRC but with no current NRC license, however, are potentially eligible for NPL designation.(b) Releases from at least three Agreement State licensees and three licensees not located in Agreement States were cleaned up through mid-1984 using Superfund money.(c) A site operated by an NRC licensee that posed imminent and substantial danger would still be eligible for Superfund cleanup money because NPL designation is not a prerequisite for cleanup in such cases.

Owners or operators of vessels over 300 gross tons carrying hazardous waste in U.S. waters must have financial responsibility coverage of $300/gross ton or $5M, whichever is greater.(d) CERCLA provides that financial responsibility can be shown by insurance, surety bond, or through qualification as a self-insurer.

3.2.3 Federal Highway Administration

The Federal Highway Administration (FHA) has minimum levels of financial responsibility for certain trucking firms that haul hazardous cargo and all interstate for-hire trucking firms to cover liability for bodily injury, property damage, and environmental restoration.(e) The required minimum levels of financial responsibility are $750,000, $1M, or $5M, depending on the degree of hazard posed by the cargo. Financial responsibility can be demonstrated through insurance or surety bonds. The FHA has issued an ANPRM to consider whether self-insurance should be allowed as a financial responsibility mechanism,(f) and another ANPRM requiring carriers to give evidence of financial responsibility to hazardous materials shippers.(g) Comparable requirements do not exist for air, water or rail carriers. A recent GAO report found that most

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(a) 48 Federal Register 40661, September 8, 1983. The decision was reaffirmed at 49 Federal Register 37074 (September 21, 1984) and 51 Federal Register 21063 (June 10, 1986).

(b) 48 Federal Register 40662. EPA's distinction between NRC and Agreement State licensees was upheld in Eagle-Picher Industries v. EPA, 759 F.2d 922 (D.C. Cir. April 16, 1985).

(c) Conference of Radiation Control Programs Directors, Inc., Frankfort, Kentucky, Profile of Radiation Control Programs in the United States for Fiscal Year 1984, Table 28. Hereafter cited as "CRCPD Profile." See Table B.1 for examples of incidents involving radioactive materials where Superfund monies have been used to finance all or part of cleanup activities.

(d) 42 U.S.C. 9608(a)(1).

(e) The requirements are based on Section 30 of the Motor Carrier Act of 1980 (49 U.S.C. 10927). They appear at 49 CFR 387.

(f) 51 Federal Register 22086, June 18, 1986.

(g) 52 Federal Register 19116, May 20, 1987.

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trucking companies use insurance to satisfy the FHA requirements and that the insurance is generally available, either in the voluntary or assigned risk markets.(a)

3.2.4 Office of Surface Mining Reclamation and Enforcement

Bonding and insurance requirements for surface coal mining operations are administered by the Office of Surface Mining Reclamation and Enforcement, U.S. Department of the Interior, and state agencies to whom regulatory authority has been delegated.(b) A performance bond is required to assure reclamation of the site at the conclusion of mining. Operators are also required to have liability insurance to cover possible personal injury and property damage.

States also have individual requirements to assure environmentally sound surface and underground mining for minerals other than coal. Wyoming, for example, has bond requirements designed to assure land reclamation, payment for any damage to surface land owners, and compliance with administrative rules.(c) Qualified operators are eligible to "self bond," i.e., execute an indemnity agreement with the state that may or may not be supported by other assets or a separate surety contract.(d)

3.2.5 State Programs

Many states have "mini-Superfunds" that are available for cleanup of hazardous material releases. At least three Agreement States also have financial assurance requirements for cleanup of accidental releases of radioactive materials.

3.2.5.1 Mini-Superfunds

In addition to the EPA-administered Superfund, approximately 39 states also have mini-Superfunds.(e) These funds generally operate similarly to the EPA Superfund. A state-by-state analysis of the potential availability of these funds for cleanup of radioactive materials releases was not conducted for this report. A 1986 Supreme Court case held that states can tax oil and chemical firms to establish a cleanup response fund to the extent that the fund does not overlap with or conflict with the federal Superfund administered by

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(a) U.S. General Accounting Office, Motor Carriers: The Availability of Environmental Restoration Insurance, GAO/RCED-86-150BR, May 1986.

(b) 30 CFR 800.

(c) Wyoming Statutes, Section 35-11-414-424.

(d) Land Quality Division, Wyoming Department of Environmental Quality, 1985 Rules and Regulations, ch. XII.

(e) H. B. Epstein, "Hazardous Waste Contamination," in Proceedings of The Pollution Liability Insurance Conference, p. 2-25, November 1986, sponsored by Executive Enterprises, Inc, New York, New York. The statutes for 36 states are assembled in Environmental Law Institute, State Superfund Statutes 1984, Washington, D.C., November 1983.

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EPA.[a] Thus, use of the state funds for cleanup of sites not on EPA's NPL is permitted.[b] Many states also have enacted laws enabling the state to place liens on the assets of dischargers to recoup cleanup expenses.

3.2.5.2 Agreement State Programs

Several Agreement States have cleanup financial assurance requirements for nuclear materials licensees in addition to the NRC requirements discussed in Section 3.2.1. As of mid-1984, eight Agreement States indicated in a survey that existing state legislation required the state radiation protection agency to adopt financial assurance requirements.[c] Another eight Agreement State agencies indicated they had legislative authority to impose such requirements at their discretion. Not all of these 16 states have existing financial assurance requirements in place. Three Agreement States that do currently have requirements are Florida, New York, and Tennessee.

Florida has legislation requiring its licensees to pay an additional 5% of their normal annual license fees into a Radiation Reclamation Fund to be used for cleanup of radioactive material releases.[d] In addition, high risk licensees will soon be required to post a surety bond to assure cleanup of releases.[e] The program is administered by the Florida Department of Health and Rehabilitative Services.

New York and Tennessee also require selected licensees to post a surety bond to assure cleanup of radioactive material releases. The New York Department of Labor requires certain materials licensees to post a bond of $10,000 or $100,000.[f] The amount of the required bond is related to the type and quantity of radioactive material. The security is to be available to reimburse the Department for cleanup expenditures. The Tennessee Division of Radiological Health, Department of Health and Environment, has extensive financial assurance requirements. The requirements are designed "to provide for the protection of public health and safety in the event of abandonment, insolvency or other inability of the licensee to perform to the satisfaction of the Director."[g] Acceptable financial assurance mechanisms include a surety bond; a personal bond supported by a letter of credit, insurance securities, or cash; and a financial test or a corporate guarantee.

(a) Exxon Corp. v. Hunt, 106 S. Ct. 1103 (1986).
(b) Epstein, op. cit.
(c) CRCPD Profile, Table 23.
(d) Florida Statutes, Sections 404.122, 404.131.
(e) Florida Administrative Code, Section 10D-91.322.
(f) New York Compilation of Codes, Rules, and Regulations, Title 12, Part 38.7.
(g) Tennessee Administrative Code, Section 1200-2-10.12.

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4.0 FINANCIAL ASSURANCE MECHANISMS: ADVANTAGES, DISADVANTAGES, COST, AND AVAILABILITY

This section discusses the various financial assurance mechanisms identified in Section 3.1, including their advantages, disadvantages, cost, and availability. The analysis suggests that although many of the mechanisms will be available to large, well-capitalized licensees, many small to medium-size licensees will be unable to find reasonably priced financial assurance in the existing marketplace. Consequently, it appears that for most licensees, one or more newly formed captive insurance companies will be the preferred way to obtain financial assurance at a reasonable cost.

4.1 CLEANUP INSURANCE FROM COMMERCIAL PROPERTY/CASUALTY INSURERS

Insurance from commercial property/casualty insurers for cleanup of radioactive materials releases could come in the form of a CGL or EIL policy or conventional property insurance. In practice, both an EIL and property insurance policy may be needed to provide for both offsite and onsite cleanup. The availability of insurance to meet the objectives of the ANPRM is likely to be very limited at the present time (see Appendix A).

4.1.1 Comprehensive General Liability Insurance

A CGL insurance policy is very unlikely to provide financial assurance for cleanup of radioactive materials releases for two reasons. First, few CGL policies cover pollution related incidents. Second, CGL policies are written to cover third party liability. Coverage for cleanup activities, especially on the premises of a licensee, is unlikely to be available as part of a CGL policy. New CGL policy forms introduced in 1986 have virtually an absolute exclusion for damages caused by pollution of any kind (Section 3.1.1.1). This exclusion was adopted for a variety of reasons, but particularly important were judicial decisions that expanded the scope of insurer liability beyond that originally contemplated.

The question of whether pollution cleanup costs are recoverable by an insured under the 1973 CGL policy form has been answered differently by the courts.[a] Some courts have held that costs for cleanup activities conducted voluntarily by an insured or pursuant to a court or government agency order are recoverable. The reasoning is generally that the insured should be indemnified for cleanup-related expenses because such expenses mitigate the possible extent

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(a) Significant cases are reviewed in S. L. Birnbaum et al., "Hazardous Waste Litigation: CGL Insurance Coverage Issues," Practising Law Institute Course Handbook No. 378, New York, New York, March 1986. Recent cases are discussed in Business Insurance, Crain Communications, Inc., Detroit Michigan, pp. 3, 32, February 2, 1987 and p. 1, February 9, 1987.

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of third party liability. Other courts have more closely followed the policy language and held that cleanup expenses are not recoverable from an insurer under a CGL policy.

4.1.2 Environmental Impairment Liability

EIL policies are written to specifically cover pollution-related risks. Policies are principally written to cover third party liability, but offsite and in some cases onsite cleanup coverage can be included with the consent of the insurer and for an additional premium. To the extent coverage is available, an advantage of the EIL policy is that it can be obtained through existing commercial insurers.

The availability of EIL policies is currently very limited. Reportedly, only the American International Group, Inc. (AIG) and the Pollution Liability Insurance Association (PLIA) offer EIL coverage.(a) Members of the PLIA group also generally require supporting insurance business, as well as a detailed engineering survey (typically costing $3,000-$10,000) to establish insurability.(b) Pollution coverage of the type offered by AIG and PLIA is customized to the hazards involved and is site-specific.(c) Maximum limits of EIL coverage are $12.5M for AIG and $2M to $4M for PLIA, with deductibles as high as $1M.(d) One commenter on the ANPRM reported potential premiums at $30 per $1000 of EIL coverage.(e) For smaller companies, this level of premium could result in a significant portion of annual income being used for insurance, rendering the option impractical. At the $30/$1,000 coverage rate, for example, the annual premium would be $3K for $100K of insurance coverage and $60K for $2M in coverage.

PNL conducted a limited, informal telephone survey of nine insurance industry representatives in October 1986. The results are summarized in

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(a) J. J. Metelski, "EIL Insurance: Handle With Care," Best's Review Property/Casualty Insurance Edition, p. 54, March 1987. As of 1986, PLIA had 24 member companies.

(b) R. A. Finlayson, "Environmental Studies Useful, But Risky," Business Insurance, p. 22, March 17, 1986.

(c) Some AIG companies provide no insurance for contract work away from a permanent facility. This is the position of member company American Home Assurance, for example. American Home Assurance also excludes nuclear hazards from coverage. Personal communication with Kathy Dwyer, American Home Assurance, March 4, 1986. See also Appendix A.

(d) R. A. Finlayson, "General Liability Policy May Be Best Chance for Pollution Cover," Business Insurance, March 17, 1986, p. 25. Colleen Mulcahy, "Outlook for EIL Market Looks Bright," National Underwriter Property & Casualty/Employee Benefits Edition, p. 3, March 23, 1987.

(e) Letter comment from Clovis S. Evans, Director, Special Projects, Navajo Refining Company on the NRC ANPRM, September 30, 1985. This approximate cost was confirmed in several comments on the EPA's Notice of Proposed Rulemaking on whether to revise financial liability coverage requirements for owners and operators of hazardous waste facilities (EPA 1985).

Appendix A. In general, the respondents confirmed that the availability of pollution-related insurance coverage is very limited. They also indicated that coverage for cleanup of radioactive materials releases would be especially difficult to find. This type of coverage is likely to be written primarily as an accommodation to an insured with substantial other insurance business, e.g., a hospital.

4.1.3 Conventional Property Insurance

Conventional property insurance typically comes with a nuclear exclusion. There are two forms of radioactive contamination assumption policy endorsement that may be added to the policy with the consent of the insurer. In the so-called "broad form," radioactive contamination is included as an insured hazard; in the "narrow form," it is covered if it results from another hazard which is insured (e.g., fire).[a] For both cases, coverage is typically limited to contamination from materials used or stored on the insured's premises. Addition of either endorsement to conventional property policies is reportedly becoming increasingly difficult.[b]

4.2 INSURANCE PROVIDED BY A CAPTIVE INSURER

Insurance provided by one or more newly-formed captive insurers appears to be the most feasible way to provide financial assurance for cleanup of radioactive materials releases for the majority of licensees. The following sections discuss advantages of captives, obstacles and issues related to formation, and likely costs.

4.2.1 Advantages

Important advantages associated with captive insurance companies include:

1. the ability to tailor the coverage of the insurance product and the language of the insurance policy to the insureds' needs--in this case cleanup of radioactive materials releases both on and off the insured's premises

2. a means to provide coverage that is otherwise either unavailable or only sporadically available

3. the ability to set terms (e.g., various deductible options) to meet the needs of the insureds

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(a) Fire, Casualty, and Surety Bulletins, Fire and Marine Section, Miscellaneous Fire Ne-1, National Underwriter Co., Chicago, Illinois, October 1980.

(b) Personal communication with Norman Cocanour, Risk Management Administrator, Arizona Public Service Company, February 21, 1986.

4. the ability to price the insurance product realistically based on the captive's owners' knowledge of their businesses and the risks associated with their operation

5. the likelihood of lower administrative and marketing costs than a noncaptive insurance company

6. a means for members to potentially gain access to the reinsurance market on a group basis

7. the ability to operate on a nonprofit basis

8. a means to provide technical services desired by the insureds (e.g., advice on accident reduction measures) with the insurance product.

Together these advantages are significant and make the captive insurance company the most attractive mechanism to provide the financial assurance contemplated in the ANPRM for most licensees under current market conditions.

4.2.2 Difficulties and Obstacles

There are also disadvantages and obstacles associated with formation of captive insurers, including capital requirements, level of risk, the need for an organizer, and licensing requirements.

4.2.2.1 Need for Capital

One disadvantage of captives to members is that a capital contribution is needed as well as annual premiums. Moreover, the capital contribution is not deductible for federal income tax purposes.(a) Annual premiums to a group or association captive will, however, generally be deductible provided ownership of the captive is widely dispersed and there is true risk shifting and risk distribution.(b)

4.2.2.2 Level of Risk

Another disadvantage is that a captive is riskier to its owners than insurance purchased through a commercial insurer. In the event of large losses, the captive member/owner's capital contributions can be wiped out through claims. Some captives also have provisions for retroactive premium assessments to cover unexpectedly high claims. Provision for retroactive assessments is often made when reinsurance is either unavailable or prohibitively expensive. Given the current reluctance of the insurance industry to

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(a) L. I. Jacobson, "Domestic and Off-Shore Captives," Techniques of Self-Insurance, Practising Law Institute Course Handbook No. 400, New York, New York, p. 99, October 1986. The Handbook is hereafter cited as "Practising Law Institute."

(b) J. W. Weber, "Tax Aspects of Captives and Other Self-Insurance Programs," Practising Law Institute, p. 119.

write coverage for pollution-related risks and especially for users of radioactive materials (see Appendix A), it seems likely that any captive insurer formed to meet the objectives of the ANPRM would need the option of retroactive premium assessment.[a] Such assessment could perhaps be limited to a stated percentage (e.g., 100%) of the normal annual premium.

4.2.2.3 Need for an Organizer

Formation of a captive insurance company composed of materials licensees will require considerable effort for an organizer. Many captives are organized through the vehicle of a trade association. As discussed in Section 2, however, nuclear materials licensees are in many types of businesses. Moreover, they are not represented by a single trade association.[b] There is consequently no natural group to lead the formation of a single captive insurer composed of materials licensees. One possibility is that separate captives could be formed for different categories of licensees. Another possibility is that one or more insurance brokers could lead the organization effort of one or more captives in return for an ownership interest, management fee, and/or brokerage business for placement of reinsurance from the resulting captive. The brokerage firms of Alexander and Alexander Services and Johnson and Higgins are currently organizing pollution-related risk retention groups on this basis.

4.2.2.4 Licensing Requirements

Finally, a captive insurer composed of materials licensees will likely need a means to write coverage in all 50 states. The captive will probably need to be licensed to conduct insurance business in at least one state. One of the states with specific legislation designed to promote the formation of captive insurers will be a probable choice. These states include Colorado, Delaware, Florida, Hawaii, Tennessee, Vermont, and Virginia. The licensing requirements in these states typically cover such things as minimum capital and surplus amounts, incorporation requirements, reporting requirements, auditing requirements, and imposition of taxes. Alternatively, a captive can seek to incorporate in an offshore jurisdiction such as Bermuda. The prior federal income tax advantages of locating off-shore, however, have largely been eliminated by the 1984 and 1986 amendments to the Internal Revenue Code (see Section 3.1.2).

(a) The organizer of a new risk retention group for EIL coverage has indicated, for example, that it does not expect to be able to obtain reinsurance. The group, Environmental Protection Insurance Co., is being organized by Alexander and Alexander Services, Inc. Business Insurance, p. 6, February 2, 1987.

(b) The trade group with the broadest applicability may be the Nuclear Suppliers Association based in Cincinnati. The Association includes 91 members involved in the manufacture or distribution of products and services for the nuclear industry. Encyclopedia of Associations, Gale Research Co., Detroit, Michigan, Vol. 1, p. 582, 1987.

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Once the captive is licensed in one state or jurisdiction it faces the problem of how to write coverage for members in other states. Unlike risk retention groups (Section 4.3), captives are not exempt from state licensing laws. The general rule, consequently, is that the captive must be licensed (i.e., admitted) in any state in which it is "doing an insurance business." In states without specific laws for captive insurers, this requirement can potentially subject a captive to the entire range of the state's insurance laws and regulations. These requirements can include organizational aspects of the captive; minimum capital and surplus requirements; limitations on investments; regulation of sales, claims handling procedures, policy forms, and rates; levying of taxes; mandatory contributions to state guarantee funds established to provide for insurer insolvency; and limitations on the captive's capacity to write new business.(a)

Fortunately there are several exceptions that have a good chance of making a captive for materials licensees eligible to write coverage without qualifying in each state as an admitted insurer. One possibility is for the captive to refrain from physically conducting business within a state. If all information regarding the captive is disseminated at an association meeting, for example, without using mail delivery, the captive may avoid the "doing an insurance business" finding.(b) This possibility is most suitable for a small association captive. The possibility of a large captive with multiple types of members using this exception is much more remote.

A second way to do insurance business without meeting all the requirements of an admitted insurer is to qualify as an surplus lines insurer. An insurer writing coverage that is otherwise unavailable through carriers licensed in a state can potentially qualify as a surplus lines carrier. Given the lack of interest by existing insurers in writing cleanup coverage (Appendix A), it seems likely that a captive could qualify as a surplus lines carrier in many states. Most states have certain regulatory requirements applicable to surplus lines insurers, but the requirements are generally less stringent than for licensed carriers. The requirements typically cover such things as the insurer's capital and surplus, length of time in business, and the insurer's regulatory status in its domiciliary (i.e., home) jurisdiction.(c) Rates and policy form language are generally not regulated. Surplus lines insurance can generally only be placed in a state through a resident broker licensed by the state to place insurance with nonadmitted insurers. Overall, surplus lines insurance is not a small business; in 1985 surplus lines insurers generated $3.9 billion in premiums in the U.S.(d)

A third possible exception is available in many states for large insureds. A nonadmitted carrier in many states can place insurance with "industrial

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(a) M. D. Brown, "Structuring and Operating a Captive Self-Insurance Program: Regulatory Aspects," p. 158, Practising Law Institute.
(b) Ibid, p. 170.
(c) M. D. Brown, ibid., p. 172.
(d) Business Insurance, p. 3, August 11, 1986.

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insureds" upon request by the insured.[a] To qualify as an industrial insured, the firm must generally have a full-time employee or consultant managing its insurance affairs. The reasoning behind this exception is that large insureds are deemed to be sufficiently knowledgeable to procure insurance without state regulatory oversight.

A final possibility for doing insurance business without becoming an admitted insurer is to find an insurer that is admitted to "front" for the captive. The fronting company issues the insurance policy and then reinsures all or a substantial portion of the risks with the captive. The fronting carrier typically charges 5 to 20% of premium revenue to provide the service. Although fronting arrangements are legal, they are not favored by state insurance regulatory agencies.[b] Moreover, finding a fronting insurer is reportedly becoming difficult.[c]

4.2.3 Issues Related to Formation

There are a variety of additional issues related to formation of a captive insurer to meet the objectives of the ANPRM. Examination of these issues is beyond the scope of this report. Nevertheless, some of them are listed below to provide an indication of the types of issues that will need to be addressed if one or more licensee captives are formed.

- How many captives are needed to cover all licensees affected by the ANPRM?
- What rules should be adopted for getting in and out of the captive and for sharing profits, if any?
- Are antitrust laws applicable if certain types of licensees are excluded?
- Should a one-time or periodic onsite inspection of some or all licensees be required as a prerequisite for coverage?
- Should the premium amount paid by a licensee reflect the licensee's past accident record and/or the results of onsite inspections conducted by the insurer or a regulatory agency?
- Should the scope of policy coverage be limited to cleanup or should it also include liability?
- Should policy dollar limits correspond to NRC requirements for each category of licensee or should different limits be made available?

(a) M. D. Brown, op cit., p. 174.
(b) M. D. Brown, op cit., p. 175.
(c) Business Insurance, p. 1, February 25, 1985.

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- Should legal defense costs be included in coverage?
- What is an appropriate deductible amount? Should more than one deductible amount be offered?
- What is the likely lead time required for establishing a captive?
- What basis should be used to compute capital requirements and premiums for each category of licensee?
- Should the insurance be marketed directly by the captive or through an insurance broker?
- Who should serve as directors and managers?
- Should claims and premium processing be done by the captive or through an insurance broker?

4.2.4 Costs

It is very difficult to estimate in advance the costs associated with formation and operation of a hypothetical captive insurer. Nevertheless, we have attempted to make rough cost estimates to permit comparison of the captive option with other financial assurance mechanisms. For purposes of estimation, costs can be broken down into four categories:

1. preliminary costs associated with formation
2. capital requirements
3. recurring administrative costs
4. costs to cover claims.

4.2.4.1 Preliminary Costs Related to Formation

Before a captive insurer is actually formed, organizers are likely to incur one-time costs for a feasibility study and professional services for legal, actuarial, and risk management assistance.[a] Captive feasibility

(a) Firms that conduct feasibility studies and provide actuarial and risk management services are listed and described in Business Insurance, p. 3, January 26, 1987.

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studies typically cost $20K to $100K, depending on complexity and scope.(a) Legal services can typically run $25K to $100K. Actuarial and risk management services can run $25K to $50K each.

4.2.4.2 Capital Requirements

A captive insurer will need an initial capital contribution from member insureds both to meet state regulatory requirements and to provide reserves in case of immediate claims. The capital would be invested to produce an income stream for the captive, to increase accumulated surplus, and perhaps to defer future premium increases.

The states with captive formation laws have various capital and accumulated surplus requirements, but the total generally does not exceed $1M. An association captive domiciled in Tennessee, for example, must have a minimum initial capitalization of $600K and an accumulated surplus of $400K.(b)

As a rough estimate, a desirable initial capitalization might be on the order of $20M. The basis for this estimate is an insurance industry rule-of-thumb that capitalization should be approximately 10 times the highest policy limit--in this case $2M (Table 1.2). The amount of initial capitalization clearly relates to the number of licensees who elect to join a captive. If only a portion of the approximately 16,350 licensees affected by the proposed rulemaking joined a captive, the $20M capitalization estimate could be unrealistically and prohibitively high.

Capital costs paid to a captive can potentially be recovered by a member/insured through profit distributions, sale of an ownership interest in the captive, or when the captive is liquidated.

4.2.4.3 Recurring Administrative Costs

One of the often stated advantages of both captives and risk retention groups is that administrative costs should be lower than for multiline insurers. A principal reason is the efficiencies associated with focusing on one insurance product. For risk retention groups, estimates place administrative costs at about 15% of premium volume versus 30 to 35% for multiline property and casualty insurers.(c) Captives faced with the licensing issues discussed in Section 4.2.2.4 are likely to have somewhat higher administrative costs than risk retention groups. One risk consultant estimates administrative

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(a) The cost estimates in Section 4.2.4.1 are from personal communication with James O. Wood, Vice President and Principal, Tillinghast Division of Towers, Perrin, Forster, and Crosby, Atlanta, Georgia, February 5, 1987; and Captive Insurance Company Reports, published by Tillinghast/TPF&C, Darien, Connecticut, p. 9, March 1987.

(b) Tennessee Code Annotated, Section 56-13-116.

(c) Business Insurance, p. 38, December 15, 1986. Risk Management, p. 2, November 1986.

costs including payments to brokers to be 25% of premium revenue.[a] In the cost analysis in Section 5.6, we have assumed that administrative costs for a hypothetical captive insurer (excluding onsite inspection costs) would be 25% of premium revenue collected for claims payment.

An additional administrative cost would be incurred if the captive's directors elect to have onsite inspections performed. Such inspections could be conducted once for new insureds or periodically for all members of the captive. The cost of onsite inspection would depend on several factors, including the frequency of inspections, the time needed for an inspection, and whether inspections are conducted by an employee of the captive or a contractor. In the captive cost analysis in Section 5.5 we have assumed for illustration that a captive composed of 16,350 licensees would spend $2M/yr for onsite inspections. Very roughly, this amount might be sufficient for 750 inspections/yr at a cost of $2,500/inspection, with the remaining $125,000 for associated administrative costs.

4.2.4.4 Cost to Cover Claims

Required annual premiums to pay claims for a captive formed to meet the objectives of the ANPRM are the most difficult cost element to estimate. A variety of factors could influence these premium requirements, including past accident history and associated cleanup costs, the types and numbers of licensees in the captive, deductible amounts on the policies, and whether reinsurance is obtained. In actual practice, a detailed actuarial study would be needed to set appropriate premiums.

An illustrative cost comparison for a captive insurer and more conventional financial assurance mechanisms is shown in Table 5.11. The portion of the annual cost to pay claims is based on risk assessment work conducted for NRC by SNL (see Section 5.6).

4.3 RISK RETENTION GROUPS/PURCHASING GROUPS

A risk retention group formed under the Liability Risk Retention Act of 1986 (the "1986 Act") is potentially a very attractive way to meet the financial assurance objectives expressed in the ANPRM. Such a group would offer the same advantages as a captive insurer (Section 4.2.1), but without the licensing restrictions that a captive faces (Section 4.2.2.4).

Unfortunately, it appears that a risk retention group cannot be used as a mechanism to provide cleanup financial assurance. Under Section 2(a)(4)(G) of the 1986 Act, risk retention groups can only be formed to provide liability insurance. The term "liability" is defined in Section 2(a)(2) as "legal liability for damages...because of injuries to other persons, damage to their property, or other damage or loss to such other persons." A risk retention

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(a) E. J. Stergiou, "Self-Insurance/Captive Programs: A Layman's Description of their Benefits," p. 151, Practising Law Institute.

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group formed to provide cleanup financial assurance for releases of radioactive materials to property not owned by the licensee would probably be acceptable under the Act. A group whose purpose included cleanup assurance for the licensee's own property would apparently not be acceptable. In most (but not all) incidents involving radioactive materials releases, the releases occur on the licensee's property.(a)

Risk retention groups have not been favored by state insurance regulators, largely because the regulators have less control over the groups than admitted insurers.(b) As of June 1986, nine states had initiated legal action against risk retention groups or purchasing groups formed under the Product Liability Risk Retention Act of 1981, the predecessor to the 1986 Act.(c) Groups have been specifically challenged on the basis that their insurance product was outside the scope contemplated by the 1981 Act. Given this background, it would seem that a risk retention group formed under the 1986 Act would offer onsite cleanup coverage at its peril. Nevertheless, one such group in formation, the North American Casualty Cooperative, does plan to cover cleanup costs that are mandated by law or are necessary to avoid further loss.(d)

The 1986 Act also provides for groups formed to purchase insurance on a group basis. Again, however, under Section 2(a)(5) of the Act such groups can only be formed to purchase liability insurance. Consequently, this option also appears to be unavailable under the 1986 Act as a mechanism to provide for onsite cleanup assurance. Moreover, there has been little interest generally among commercial insurers in providing insurance to businesses on a group basis.(e)

Except for the limitation to liability coverage, the 1986 Act would be an attractive means to provide cleanup assurance. It is possible that if a suitable case could be made to Congress, the Act could be amended to include property insurance such as onsite cleanup coverage.

(a) In some cases the property may be leased rather than owned by the licensee, however.

(b) See for example: 1) National Underwriter Property and Casualty Insurance Edition, October 31, 1986, p. 6 and December 5, 1986, p. 6; and 2) Risk Management, p. 18, March 1987.

(c) U.S. General Accounting Office, Activity Under the Product Liability Risk Retention Act of 1981, GAO/HRD-86-120BR, p. 17, July 1986.

(d) Business Insurance, p. 2, November 17, 1986. P. M. Donovan, "Nontraditional Approaches to Improve Pollution Insurance Capacity," Proceedings of the Pollution Liability Insurance Conference, sponsored by Executive Enterprises, Inc., New York, New York, November 1986.

(e) V. C. Gudmundsen, "Group Property and Casualty Insurance: Annotations to the NAIC Model Act," Journal of Insurance Regulation, p. 235, December 1986. The author also points out that group insurance for businesses where individual premiums do not reflect past accident history may violate public policy because a business could be virtually guaranteed insurance coverage regardless of how carelessly it conducts its operations.

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4.4 SURETY BONDS

Surety bonds (described in Section 3.1.4) are written for a wide variety of purposes including the payment of taxes and the closure of surface mines and hazardous waste facilities. The bonds come in several forms. The two of most interest for radioactive materials cleanup operations are financial guarantee bonds and performance bonds. Under a financial guarantee bond, the surety company guarantees for a fee that a specific amount of money will be available for cleanup if the owner or operator of a licensed facility fails to perform cleanup.[a] Under a performance bond, the surety company would either undertake the cleanup with its own contractor or pay the penal sum of the bond should the owner-operator fail to perform.[b] Under the objectives of the ANPRM, surety companies would be asked to provide funds to perform a cleanup operation up to the face value of the bond if an accident occurred and the bonded licensee failed to perform the operation. Surety companies generally prefer situations where their own exposure to loss is limited, where the principal's required actions are easily identifiable and extend over a limited period, and where the surety company can unilaterally cancel the coverage (with perhaps 30 to 90 days' notice) if it feels that risks are unacceptable.[c] Also, surety companies prefer situations where the amount of the bond remains fixed over time and the principal is a good credit risk.[d] A rule of thumb used by sureties for relatively easily measured financial guarantee situations such as sales tax collection bonds is that the bond should be for no more than 10% of the principal's net worth. Cleanup costs associated with radioactive materials releases are a less easily measured risk, and may be subject to a more restrictive test. However, as in banking, a decision regarding a principal's credit-worthiness is affected by composition of assets and net worth as well as more subjective considerations.[e]

Bonds are required for coal mine reclamation by the Office of Surface Mining Reclamation and Enforcement (Section 3.2.4) and are an option permitted by the State of Tennessee (Section 3.2.5) for financial assurance related to cleanup of accidental releases of radioactive material and similar events (such as abandonment of a contaminated facility). According to the Surety Association of America, the main difference between the situations posed by mine reclamation and cleanup activities resulting from releases of radioactive materials is that mine reclamation activity is likely to be short term (the bulk of the work is done in two to three years) and limited to actions outlined in a prefiled reclamation plan (e.g., fill in the pit, contour the landscape, plant seed, and monitor for ten years). Even though in practice the cleanup of released radioactive material may require only hours in some cases, underwriters are concerned that the extent of the principal's required activities

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(a) EPA, Financial Assurance for Closure and Post-Closure Care: A Guidance Manual, SW-955, 1982.
(b) Ibid.
(c) Personal communication with D. E. Wine, The Surety Association of America, February 21, 1986.
(d) Ibid.
(e) Ibid.

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may extend over a long period of time or may carry an expanding cost obligation (larger face amounts for the bond) as regulations evolve. The bond underwriter may prefer to cancel rather than take on expanded obligations as regulations change, but the quality of the credit risk does not.(a)

Another concern of surety companies is the difficulty in quantifying the "tail" (delayed liability) obligation in environmental cleanup situations. This difficulty complicates the companies' ability to predict the total cost obligation the bond must actually cover. This uncertainty has led in some cases to a decline in the availability of performance bonds for surface mine reclamation.(b) The growing size of financial requirements has also been a problem in the surety bond market.(c)

In spite of the difficulty of assuring open-ended performance obligations with bonds, Tennessee appears to have had some success with requiring performance bonds for cleanup of accidental releases from materials licensees. The state has several licensees with bonds ranging in size from a few hundred thousand dollars to $1.5M.(d) The program has been in effect for about three years, and no licensees have been unable to secure bonds. The period of performance on the cleanup operation is typically left open and the cleanup required is "to the satisfaction of the Commissioner of Health and Environment."(e) Although there have been no claims under these bonds (so it is really unknown how extensive the offerings of bonds may be if there is ever a loss), the Tennessee experience appears to show that relatively open-ended obligations for cleanup can be supported by surety bonds in some circumstances.

Surety bonds are written for obligations ranging from a few thousand dollars to several million dollars. Although companies having a net worth less than $50M probably would not qualify for a $2M cleanup bond (see Section 4.9), for those that do it is estimated that the annual cost would be about $20 per $1,000 of coverage.(f) At a rate of $20/$1,000 the annual cost for $100,000 of coverage would be $2,000 and for $2M in coverage it would be $40,000. Another aspect of the cost to the licensee is that, in contrast to insurance contracts,

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(a) Ibid.
(b) Ibid.
(c) Ibid.
(d) Personal communication with Michael Mobley, Director, Tennessee Division of Radiological Health, February 21, 1986 and October 16, 1986. Limited use also has been made of standby letters of credit and corporate guarantees. These financial assurance mechanisms are described in Sections 4.5 and 4.6.
(e) Ibid.
(f) The $50M estimate is from personal communication with D. E. Wine, Surety Association of America, March 18, 1986. The $20/$1,000 coverage estimate is from D. E. Wine and a written comment on the ANPRM from Cardiovascular Consultants of Nevada, September 23, 1985. A range of 1.5-2.0%/yr or $15-$20/$1000 of coverage is cited as a likely cost range for surety bonds in R. S. Wood, Assuring the Availability of Funds for Decommissioning Nuclear Facilities, NUREG-0584 Rev. 3, Draft Report, p. 37, March 1983.

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the surety company would likely seek recovery from the licensee for funds paid out under the surety obligation.[a]

4.5 STANDBY LETTERS OF CREDIT

Standby letters of credit are issued as backup assurance that a company or individual will perform as expected. They are written by lending institutions, stating conditions under which the institution agrees to accept drafts (a written order for a sum of money, originating with a creditor and naming a debtor) to be applied against previously established credit. Letters of credit are usually used in commercial transactions, especially for the sale of goods. They are occasionally used to guarantee performance. In this case, the instrument is a standby letter of credit. It is different from a commercial letter of credit because of the absence of an underlying trade transaction. Banks tend to reserve access to standby letters of credit for their best customers.[b] Tennessee's regulations (Section 3.2.5) permit standby letters of credit as a means of financial assurance, but stipulate that such letters must be irrevocable for at least one year.[c] Lending institutions regard standby letters of credit as potential loans involving the usual types of credit risk. The question of the availability of standby letters of credit obviously relates to the credit risk the lending institution believes is imposed by the licensee. Thus, the availability of standby letters of credit may be similar to surety bonds.[d]

One problem that can arise with standby letters of credit is that some banks issue them without the financial means available to make a cash payment if required. Therefore, if this mechanism is used it may be necessary to review the financial status of the bank issuing the letter.[e]

The annual cost of a standby letter of credit can be as little as 1/16 of 1% of the credit amount[f] to as much as 3%.[g] For this report we have used 1.5% or $15 per $1,000 coverage as a representative cost.[h] At this rate, a $100,000 standby letter of credit would cost the licensee $1,500 per year while

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(a) Written comment on the ANPRM from D. E. Wine, Vice-President, Surety, The Surety Association of America, Iselin, New Jersey, June 17, 1985.
(b) Memorandum from S. B. Siegel, ICF, Inc. to Deborah Wolpe, FRP/OSW, EPA on Cost and Availability of Credit and Trust Funds for providing Assurance for Corrective Measures, June 13, 1985.
(c) Personal communication with Michael Mobley, Director, Tennessee Division of Radiological Health, February 21, 1986.
(d) Personal Communication with Richard D. Clark, First Interstate Bank, Portland, Oregon, March 28, 1986.
(e) Ibid.
(f) American Banker, p. 10, August 28, 1985.
(g) J. A. McDonald, "Understanding the Risks in Standby Letters of Credit," Commercial Lending Review, p. 34, Summer 1986.
(h) A range of 0.5 to 1.5% is cited as a likely range in R. S. Wood., op cit.

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a $2M letter would cost $30,000 annually. The licensee would also have to repay with interest any funds actually drawn against the letter.

4.6 DEPOSIT OF SECURITIES OR CASH IN TRUST OR ESCROW ACCOUNTS

Trust and escrow accounts are potentially available for all licensees. A significant problem with using these accounts, however, is that even if the licensee is permitted to retain the earnings of the escrow or trust account and even if he can receive the funds back at some future date (e.g., when his license expires or is relinquished or when the accumulation of income in the escrow or account's sufficient to permit release of the original principal), the obligation to prepay between $100,000 and $2M will significantly impact all but highly capitalized materials licensees. Many licensees would simply be unable to generate the required deposit and would likely either cease operation or switch to an alternative technology that does not require a radioactive materials license. One possible way to mitigate the impact of this mechanism is to allow an extended period of time (say five years) in which to pay into the fund. A potential disadvantage of periodic payments is under-funding and hence under-assurance in the event of an accident early in the fund's life. The main cost of a trust fund is foregone earnings on the principal set aside in the account.(a) An estimate of the financial cost of an escrow or trust account is computed in Section 5.1.5.

Trust funds with periodic payments are currently being used in several states to assure the availability of funds for decommissioning nuclear power reactors.(b) Some states (e.g., Maine) also allow periodic payments into a trust fund to assure proper closure of hazardous waste facilities regulated under the Resource Conservation and Recovery Act.(c)

4.7 FINANCIAL TESTS/CORPORATE GUARANTEES

A financial test coupled with a guarantee applied to a licensee, its corporate parent, or both could be used as a financial assurance option.(d)

(a) Trust fees charged by financial institutions are typically between 0.1% and 1% of the account principal. This would be an additional cost. Memorandum from S. B. Siegel, ICF, Inc. to Deborah Wolpe, FRP/OSW, EPA, June 13, 1985.

(b) See Section 3.1.4.

(c) U.S. General Accounting Office, Hazardous Waste: Environmental Safeguards Jeopardized When Facilities Cease Operating, GAO/RCED-86-77, p. 34, February 1986.

(d) Current NRC financial assurance policy for uranium recovery facilities (10 CFR 40 Appendix A, Criterion 9) is that only a parent company passing a financial test can provide the guarantee. The licensee itself cannot provide a guarantee through a financial test. NRC Division of Waste Management, Draft Technical Position on Financial Assurances for Reclamation, Stabilization, Decontamination and Long Term Care of Uranium Recovery Facilities, October 1986. If this policy is followed, a financial test applied to licensees would not be an alternative financial assurance mechanism for the proposed rulemaking.

Although such a test or guarantee has the advantage of being relatively low cost, there are several potential concerns. First, depending on how the financial test is constructed, it may not be possible for smaller licensees to meet the test because the potential cleanup obligation may exceed their net worth (or exceed some portion of their net worth that is considered prudent). Second, it is important to note that the financial condition of companies can change rapidly. Finally, the NRC and Agreement States could rely on a financial statement without necessarily knowing the full extent of a licensee's nuclear-related activities in other Agreement States.

An example of a possible financial test is the test used by the state of Tennessee (see Section 3.2.5).[a] Under these requirements, a licensee can provide adequate financial assurance by meeting all four tests under either (A) or (B).

(A) The licensee applicant or licensee must have:
  - I. Two of the following three ratios: a ratio of total liabilities to net worth less than 2.0, a ratio of the sum of net income plus depreciation, depletion and amortization to total liabilities greater than 0.1, and a ratio of current assets to current liabilities greater than 1.5;
  - II. Net working capital and tangible net worth each at least six times the current reclaiming cost estimate;
  - III. Tangible net worth of at least $10M; and
  - IV. Assets in the United States amounting to at least 90 percent of total assets or at least six times the current reclaiming cost estimate.[b]

(B) The applicant or licensee must have:
  - I. A current rating for the most recent bond issuance of AAA, AA, A or BBB as issued by Standard and Poor's or Aaa, Aa, A or Baa as issued by Moody's;
  - II. Tangible net worth at least six times the current reclaiming cost estimate;
  - III. Tangible net worth of at least $10M; and
  - IV. Assets located in the United States amounting to at least 90 percent of total assets or at least six times the current reclaiming cost estimate.

Most NRC and Agreement State licensees meeting the NRC definition for small businesses (Section 5.3) would fail the net worth criterion in the Tennessee regulations at the $2M level of financial assurance, and many would also fail even with the risk-base sliding scale of required coverage (Table 1.2).

(a) Tennessee Administration Code, Section 1200-2-10.12. At least one large licensee has applied to use this method in Tennessee. Permission is expected to be granted. Personal communication with Michael Mobley, Director, Tennessee Division of Radiological Health, October 16, 1986.

(b) The term "reclaiming cost" refers to the estimated cleanup cost for an accidental release or for cleanup of an abandoned facility.

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Average total assets for small firms in the industries covered by the ANPRM in 1982 and 1983 were generally less than $1M, and usually less than $500,000.(a)

The parent company guarantee option is unavailable, of course, to those licensees that do not have a corporate parent. There is also the uncertainty associated with a guarantee if the corporate parent should enter bankruptcy or if the corporate parent or the subsidiary is sold to another entity. In addition, under some state laws there is a question whether such financial guarantees would be acceptable under laws regulating the activities of companies issuing insurance.(b)

Costs of financial tests and corporate guarantees are difficult to estimate since the funds for cleanup need not actually be set aside. EPA financial assurance regulations applying to closure and post-closure activities at hazardous waste facilities regulated under the Resource Conservation and Recovery Act allow site owners and operators to satisfy financial assurance requirements with such tests and guarantees. While the wording of the corporate guarantee stipulates that something of value be given to the corporate parent in exchange for the guarantee, this language is inserted primarily to ensure that the guarantee agreement will be recognized as a valid legal contract. The amount that is actually passed from subsidiary to parent may be as little as one dollar.(c) Discussions with a few companies having hazardous waste facilities confirmed that the only costs of corporate guarantees are the companies' administrative costs of performing calculations, securing audits, filing the appropriate paperwork, and related administrative functions. These costs are difficult to accurately estimate.(d) However, an EPA staff person estimated a before tax cost of $500 per licensee to perform the necessary administrative functions.(e) This estimate is presumably independent of the level of coverage required. For this report we have assumed an after tax-cost of $300 per licensee.

4.8 EXPANSION OF PRICE-ANDERSON INSURANCE POOLS

The Price-Anderson insurance pools were formed to allow licensees subject to the Price-Anderson Amendments to the Atomic Energy Act to meet financial

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(a) U.S. Department of the Treasury, Internal Revenue Service, Statistics of Income Division, Source Book Statistics of Income: Active Corporation Income Tax Returns July 1982-June 1983, Publication 1053 (Rev. 3-85), March 1985. (Hereafter cited as "IRS 85").

(b) This point was made in the EPA notice soliciting comments on the availability of insurance for hazardous waste site operators. 50 Federal Register 33902, August 21, 1985.

(c) EPA, Financial Assurance for Closure and Post-Closure Care: A Guidance Manual, SW-955, p. VII-1, 1982.

(d) Personal communications with Terry Gilbraith, Cominco-American Inc., Spokane, Washington, May 21, 1986; Harold Dubec, Occidental Chemical Co., Niagara Falls, New York, May 21, 1986; James Petros, Union Carbide Co., Danbury, Connecticut, May 21, 1986.

(e) Memorandum from Tom Gillis to Carol Ansheles, EPA Office of Surface Water, April 1986.

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protection requirements imposed by Congress and NRC (see Section 3.2.1.4). If NRC chose to extend financial protection requirements to materials licensees, it is possible that the pools could be expanded to include coverage for these additional licensees. The pools themselves have indicated that coverage should be sought in the conventional insurance market.(a)

Insurance is available to qualified "nuclear facility" sites--reactors, fuel labs, waste burial sites--that are subject to NRC's financial protection requirements for onsite property contamination and offsite liability (Section 3.2.1.4). Insurance is also available for companies such as transporters engaged in specific types of nuclear material transportation and firms engaged in providing products and services to power and research reactors. Radioisotopes are covered only incidentally to more significant nuclear material exposures (e.g., spent fuel) and only on the facility site. The American Nuclear Insurers (ANI) and Mutual Atomic Energy Reinsurance Pool (MAERP) consortium does not insure persons or organizations who have "routine or incidental exposures" (most isotope users) or mining and milling operations.(b) While in principle it appears that coverage could be extended to these categories of licensees or that a new ANI-MAERP insurance pool could be formed, such coverage is not currently available.

4.9 RELATIVE AVAILABILITY OF EXISTING FINANCIAL ASSURANCE MECHANISMS

Cleanup assurance provided by one or more newly-formed captive insurers appears to be the most feasible way to provide the financial assurance contemplated in the ANPRM. Such an insurer does not currently exist, however. This section discusses the relative availability of the financial assurance mechanisms that are currently available.

None of the existing financial mechanisms except an escrow account is available to all the licensees covered by the ANPRM. Pollution-related coverage from commercial property and casualty insurers is currently very difficult to obtain. Insurers seem to have little interest in providing the type of financial assurance contemplated in the ANPRM (see Appendix A). Surety bonds and letters of credit, though currently less expensive than insurance from property and casualty insurers, would likely be available only to well-capitalized licensees because they are in essence potential loans based on the borrower's credit risk. The majority of licensees covered by the ANPRM may be too small to qualify for the necessary level of assurance. The small size of most of the licensees also would make it difficult if not impossible for them to set aside enough money in an escrow or trust account to satisfy the requirements of the ANPRM unless the payments could be made very gradually. Finally,

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(a) Letter comment from Burt C. Proom, President, American Nuclear Insurers and J. Michael O'Connell, Manager, Mutual Atomic Energy Reinsurance Pool on the ANPRM, December 30, 1985.

(b) Ibid.

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their small size also means that most of the licensees covered by the ANPRM could not meet reasonable financial asset tests for the level of assurance required.

To determine whether materials licensees could be expected to meet potential financial tests that might be required under the financial test/corporate guarantee, surety bond, and letter of credit options, we performed a financial analysis of businesses that include these licensees. Internal Revenue Service (IRS) data were used in the analysis.(a) Licensees from the DRR survey discussed in Section 2.1 were categorized by level of sales and matched as closely as possible by their principal line of business with the 4-digit industry categories reported by the IRS. Financial statistics were then derived for average firms in these industry categories by level of annual sales. Nonprofit institutions were assumed to have the same financial characteristics as comparable for-profit institutions. The analysis thus assumes that the DRR survey licensees are similar in financial structure to the corporations in the corresponding IRS industry category at the corresponding level of sales. Because this assumption does not necessarily hold, the results of the analysis are only suggestive, not definitive. However, no direct information was available on the financial structure of materials licensees to permit a more definitive analysis.

The financial tests chosen for this analysis are based on the state of Tennessee's financial test requirements discussed in Section 4.7. These requirements are identical to the tests utilized by EPA for financial assurance related to closure and post-closure care of hazardous waste facilities.(b) GAO reported that about 75% of 176 hazardous waste facilities surveyed utilized the financial tests to provide financial assurance for closure and post-closure care.(c) However, it should be pointed out that the dollar value of assurance for closure and post-closure care of these hazardous waste facilities in some cases was considerably less than the $2M contemplated in the ANPRM.(d) We also performed financial tests for surety bonds, using the rule of thumb that the face value of the bond should ordinarily not be more than 10% of the principal's net worth. The same test is also assumed to apply to the availability of standby letters of credit.

Table 4.1 reports the results of the corporate guarantee financial analysis for the $2M blanket coverage and for the risk-based sliding scale of coverage (Table 1.2) for licensees at three levels of annual sales: $1M, $7M, and $25M. Corporate net worth, working capital, assets, and liabilities were

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(a) IRS 1985.
(b) See 40 CFR 264.143(f) and 264.143(e).
(c) U.S. General Accounting Office, Hazardous Waste: Environmental Safeguards Jeopardized When Facilities Cease Operating, GAO/RCED-86-77, p. 3, February 1986.
(d) Personal communication with Charles Bausell, GAO, Washington, D.C., October 23, 1986.

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TABLE 4.1. Results of Financial Tests by Category of Licensee, Level of Coverage, and Annual Sales

Category of Licensee and Financial Test[a,b]	Blanket $2 Million Coverage Annual Sales $1M	$7M	$25M	Sliding Scale Coverage Annual Sales $1M	$7M	$25M
I. Research, Teaching, Diagnostic, Therapeutic						
a. Less than 0.1 Curie						
i) Financial Ratios	Fail	Fail	Fail	Fail	Fail	Fail
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Pass	Pass
b. 0.1 to 1 Curie						
i) Financial Ratios	Fail	Fail	Fail	Fail	Fail	Fail
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Pass	Pass
c. 1 to 10 Curies						
i) Financial Ratios	Fail	Fail	Fail	Fail	Fail	Fail
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Total Net Worth	Fail	Fail	Pass	Fail	Fail	Pass
d. 10 to 100 Curies						
i) Financial Ratios	Fail	Fail	Fail	Fail	Fail	Fail
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Fail	Pass
e. More than 100 Curies						
i) Financial Ratios	Fail	Fail	Fail	Fail	Fail	Fail
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Fail	Pass
II. Measurement, Calibration, Irradiation						
a. Less than 0.1 Curie						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Pass	Pass
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Pass	Pass
b. 0.1 to 1 Curie						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Pass
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Pass	Pass
c. 1 to 10 Curies						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Pass
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Pass	Pass
d. 10 to 100 Curies						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Fail	Pass
e. More than 100 Curies						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Fail	Pass

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TABLE 4.1. (contd)

Category of Licensee and Financial Test[a,b]	Blanket $2 Million Coverage Annual Sales $1M	$7M	$25M	Sliding Scale Coverage Annual Sales $1M	$7M	$25M
III. Manufacturing and Distribution						
a. Less than 0.1 Curie						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Pass	Pass
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Pass	Pass
b. 0.1 to 1 Curie						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Pass	Pass
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Pass	Pass
c. 1 to 10 Curies						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Pass
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Pass	Pass
d. 10 to 100 Curies						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Fail	Pass
e. More than 100 Curies						
i) Financial Ratios	Fail	Pass	Pass	Fail	Pass	Pass
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Fail	Pass
IV. Waste Processing and Storage						
i) Financial Ratios	Fail	Fail	Fail	Fail	Fail	Fail
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Fail	Pass	Fail	Fail	Pass
V. Fuel Cycle						
i) Financial Ratios	Pass	Fail	Fail	Pass	Fail	Fail
ii) Net Worth, Working Capital Versus Cost	Fail	Fail	Fail	Fail	Fail	Fail
iii) Total Net Worth	Fail	Fail	Fail	Fail	Fail	Fail
iv) Assets Versus Cost	Fail	Pass	Pass	Fail	Pass	Pass

(a) Classifications of licensees are described in Appendix C.

(b) The financial tests are as follows. First, the firm must have 2 out of 3 of the following ratios: liabilities divided by net worth <2.0; net income plus amortization, depreciation, and depletion >0.1; and current assets divided by current liabilities >1.5. Second, both the firm's tangible net worth and working capital must be at least 6 times covered cost. Third, net worth must be at least $10 million. Fourth, assets must be at least 6 times covered cost (see text).

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estimated for companies at these sales levels. The Tennessee (and EPA) regulations (Section 4.7) require that a firm pass either of two alternative sets of four tests. In either case, all four tests must be passed. We used Set A in preparing Table 4.1. First, the firm must pass two out of three financial ratio tests: the ratio of liabilities to net worth must be less than 2.0, net income plus amortization, depreciation, and depletion must be at least 0.1 times liabilities, and current assets must be at least 1.5 times liabilities. In many cases, average firms at all sales levels examined either passed only one out of these three ratios, or else failed all three. Measurement, calibration, and irradiation firms and firms engaged in manufacturing and distribution generally passed two of the required financial ratio tests if their sales exceeded $7M.

The second test requires that both net working capital (current assets less current liabilities) and tangible net worth (total tangible assets minus total liabilities) of the firm be at least 6 times the cost of cleanup (required coverage). Both $2M blanket coverage and the sliding scale coverage shown in Table 1.2 were analyzed. At the lower levels of sliding scale coverage of $100,000 to $500,000 (10 curies or less), firms having $7M or $25M in sales were sometimes able to pass this second test, but smaller firms generally were not.

The third test requires that net worth exceed $10M. Average firms in the $1M, $7M, and $25M sales categories were again examined. All categories of firms failed this test at all three sales levels.

The fourth test requires that 90% of the firm's assets be within the United States or be at least six times the cost of cleanup. It was not possible to determine the geographical location of assets, so the second part of the test was used. Several categories of firms passed this test at the $25M sales level, but only fuel cycle firms passed at the $7M sales level. Licensees doing business mainly within the United States probably could also pass this test since almost all of their assets would be located in this country.

Table 4.1 shows that licensees having average financial conditions and annual sales up to $25M were unable to pass all four financial tests. Large manufacturing firms came the closest, passing on three out of four tests, but failing on net worth. There is probably enough variability in the financial conditions of individual firms that the averages reported in Table 4.1 may be somewhat misleading; that is, some individual licensees may actually qualify under these financial tests.(a) In addition, those corporate subsidiary licensees that can obtain a guarantee from a large corporate parent and use its assets may be able to pass the tests.(b) However, in general it appears that

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(a) In Tennessee, at least one large licensee may have qualified. See Section 4.7.

(b) If NRC follows its policy for uranium recovery facilities, a parent guarantee may be the only way to meet the corporate guarantee/financial test (see Section 4.7).

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the corporate parent will have to be larger than any of those analyzed in Table 4.1 to guarantee a subsidiary's qualification.

Table 4.2 contains information on the likely availability of surety bonds and standby letters of credit to licensees. In preparing the table, we used the rule of thumb employed by many surety companies that, for easily measured financial guarantees, the face value of the bond should generally be no more than the 10% of the principal's net worth. In reality, because the probability and extent of cleanup is not well understood, sureties might not be willing to write a bond this large for a licensee. Table 4.2 thus likely reports an upper bound estimate of the maximum-sized bond that could be written for a licensee having net worth equal to the average for corporations in the corresponding IRS industry and having the level of sales shown. The table also indicates whether the maximum is sufficient to provide the required cleanup coverage.

The results shown in Table 4.2 indicate that no category of firms up to $25M in annual sales would be able to secure $2M in coverage, while the results are only somewhat better for the sliding scale coverage shown in Table 1.2. Although these results only apply to average firms at each level of sales (so that licensees having unusually strong financial positions might be able to qualify for bonds to cover cleanup obligations),[(a)] it should also be remembered that 10% is perhaps a somewhat generous rule of thumb for qualification. Much the same results may be expected for standby letters of credit.

Finally, Table 4.3 summarizes the number of licensees covered by the ANPRM that appear to be qualified to utilize the corporate guarantee (the least expensive existing option), bonds and standby letters of credit (the next least expensive), and commercial insurance or escrow mechanisms (the most expensive of existing options). At each level of sales it is assumed that the least expensive option would be used; e.g., if a licensee qualified for both corporate guarantees and surety bonds, it would use corporate guarantees. The table values were calculated by making the following assumptions:

1. We assume that half the licensees with over $25M in annual sales qualify under a financial test or corporate guarantees.

2. Where Table 4.2 shows that licensees with a given level of sales can qualify for surety bonds large enough to provide coverage, we assume that all the licensees larger than this who do not qualify for corporate guarantees, plus half of those in the next smaller size category, are assumed to use bonds or standby letters of credit. For example, for sliding scale coverage in the category of research, teaching, diagnostic, and therapeutic licensees with less than 0.1 curie, the group using surety bonds and standby letters of credit contains half of the licensees with sales over $25M, plus half of those with sales between $7M and $25M, or 1019 licensees.

(a) Tennessee, an Agreement State, has a few materials licensees with surety bonds (see Section 4.4).

TABLE 4.2. Maximum Size of Bond and Adequacy of Coverage by Category of Licensee, Type of Coverage, and Annual Sales

Category of Licensee and Coverage with Sliding Scale[a]	$1M Sales			$7M Sales			$25M Sales		
	Maximum Size of Bond[b]	Adequate to Supply Coverage		Maximum Size of Bond[b]	Adequate to Supply Coverage		Maximum Size of Bond[b]	Adequate to Supply Coverage	
		$2M Blanket	Sliding Scale		$2M Blanket	Sliding Scale		$2M Blanket	Sliding Scale
I. Research, Teaching, Diagnostic, Therapeutic									
a. Less than 0.1 Curie ($0.1M)	$1,500	No	No	$45,500	No	No	$313,100	No	Yes
b. 0.1 to 1 Curie ($0.25M)	1,500	No	No	45,500	No	No	313,100	No	Yes
c. 1 to 10 Curies ($0.5M)	1,500	No	No	45,500	No	No	313,100	No	No
d. 10 to 100 Curies ($1.0M)	1,500	No	No	45,500	No	No	313,100	No	No
e. More than 100 Curies ($20M)	1,500	No	No	45,500	No	No	313,100	No	No
II. Measurement, Calibration, Irradiation									
a. Less than 0.1 Curie ($0.1M)	$16,600	No	No	$169,400	No	Yes	$677,700	No	Yes
b. 0.1 to 1 Curie ($0.25M)	16,600	No	No	169,400	No	No	677,700	No	Yes
c. 1 to 10 Curies ($0.5M)	16,600	No	No	169,400	No	No	677,700	No	Yes
d. 10 to 100 Curies ($1.0M)	16,600	No	No	169,400	No	No	677,700	No	No
e. More than 100 Curies ($2.0M)	16,600	No	No	169,400	No	No	677,700	No	No
III. Manufacturing and Distribution									
a. Less than 0.1 Curie ($0.1M)	$13,200	No	No	$306,800	No	Yes	$593,900	No	Yes
b. 0.1 to 1 Curie ($0.25M)	13,200	No	No	306,800	No	Yes	593,900	No	Yes
c. 1 to 10 Curies ($0.5M)	13,200	No	No	306,800	No	No	593,900	No	Yes
d. 10 to 100 Curies ($1.0M)	13,200	No	No	306,800	No	No	593,900	No	No
e. More than 100 Curies ($2.0M)	13,200	No	No	306,800	No	No	593,900	No	No
IV. Waste Processing and Storage ($2.0M)	$15,600	No	No	$148,200	No	No	$620,700	No	No
V. Fuel Cycle ($2.0M)	$21,600	No	No	$512,600	No	No	$298,800	No	No

(a) For categories, see Appendix C.
(b) Maximum size of bond is based on 10% of net worth for average firms in each category. Bond size is rounded to nearest $100.

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TABLE 4.3. Estimated Number of Licensees Qualifying for Financial Assurance Mechanisms, by Category of Licensee and Type of Coverage

Category of Licensee	Number of Licensees[a]	$2M Blanket Coverage			Sliding Scale Coverage		
		Number Qualifying for Corporate Guarantee[b]	Number Qualifying for Bonds, Letters of Credit[c]	Number Qualifying for Escrow or Insurance Only	Number Qualifying Under Financial Test[b]	Number Qualifying for Bonds, Letters of Credit[c]	Number Qualifying for Escrow or Insurance Only
I. Research, Teaching, Diagnostic, Therapeutic							
a. Less than 0.1 Curie	3,498	626	312	2,560	626	1,019	1,853
b. 0.1 to 1 Curie	1,116	199	100	817	199	326	591
c. 1 to 10 Curies	1,772	317	158	1,297	317	158	1,297
d. 10 to 100 Curies	372	66	33	273	66	33	273
e. More than 100 Curies	531	95	47	389	95	47	389
II. Measurement, Calibration, Irradiation							
a. Less than 0.1 Curie	4,151	686	342	3,123	686	1,725	1,740
b. 0.1 to 1 Curie	1,486	245	123	1,118	245	364	877
c. 1 to 10 Curies	1,089	180	90	819	180	266	643
d. 10 to 100 Curies	346	57	28	261	57	28	261
e. More than 100 Curies	1,181	195	97	889	195	97	889
III. Manufacturing and Distribution							
a. Less than 0.1 Curie	228	48	23	157	48	108	72
b. 0.1 to 1 Curie	162	34	17	111	34	66	51
c. 1 to 10 Curies	129	27	13	89	27	38	64
d. 10 to 100 Curies	161	33	17	111	33	17	111
e. More than 100 Curies	66	13	7	46	13	7	46
IV. Waste Processing and Storage	33	0	0	33	0	0	33
V. Fuel Cycle	28	7	3	18	7	3	18
Total	16,349	2,828	1,410	12,111	2,828	4,313	9,208
Percentage	100.0%	17.3%	8.6%	74.1%	17.3%	26.4%	56.3%

(a) For the number of licensees, see Appendix C.
(b) Half of all licensees having more than $25M in annual sales. See footnote (b) to Table 4.1 for the financial test.
(c) Half of all licensees over $25M in annual sales not qualifying for corporate guarantees, plus all those with sales greater than qualifying levels in Table 4.2, plus half of licensees in the next smaller size class.
(d) Number of licensees, less those qualifying for corporate guarantees, bonds, or letters of credit.

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3. All remaining licensees are assumed to qualify for escrow or commercial insurance from an existing property/casualty insurer.

Table 4.3 indicates that with $2M blanket coverage, about 17% of all licensees might be able to qualify under a financial test. This number does not change with sliding scale coverage. The reason is that, as Table 4.1 indicates, no licensees at even the $25M annual sales level appeared to satisfy all four financial tests. As was discussed in relation to Table 4.1, however, some individual licensees may qualify even though the average firm would not. This appears most likely for the largest licensees, half of whom were assumed to qualify in Table 4.3.

Table 4.3 also indicates that between about 9% of all licensees (with $2M blanket coverage) and about 26% of all licensees (with sliding scale coverage) could potentially qualify for a surety bond or letter of credit large enough to supply the required level of financial assurance. Table 4.3 potentially overestimates the number of licensees who could qualify for bonds and standby letters of credit, since the rule used to determine qualification is perhaps overly generous. In Section 4.4 it was noted that access to surety bonds might be restricted to firms having net worth of $50M or more.

Finally, Table 4.3 indicates that with either $2M blanket coverage or sliding scale coverage, over half of the licensees may have to rely on escrow accounts or commercial insurance to provide the required financial assurance.(a) With sliding scale coverage, this number includes all of the licensees having less than $1M in sales, as well as 83% of those with annual sales between $1M and $7M and about 47% of those with annual sales of $7M to $25M. With $2M blanket coverage, all licensees except those with over $25M in sales would have to resort to escrow or commercial insurance coverage if the assumptions utilized in this section are correct.

Based on the analysis of the less expensive conventional mechanisms, more than half of the materials licensees affected by the ANPRM likely would have to resort to commercial insurance or escrow accounts. Escrow accounts are likely to be prohibitively expensive (see Section 5.1.6). Insurance is a logical mechanism because it permits the pooling of risks posed by individual licensees and the spreading of such risks to the overall insurance industry through reinsurance. Thus, the financial size of the individual licensee is not a barrier to coverage so long as he is able to pay the premiums. The current problem of lack of availability of CGL, EIL, and property insurance for materials licensees covered by the ANPRM appears to be related to underwriters' lack of reliable information concerning the degree of risk posed by licensee operations. However, it is possible that commercial property/casualty insurers might provide the needed coverage in the future. There are several precedents, for example, for eventual coverage of "new" risks during this century in the U.S. Previous new risks and large-scale losses posed by big city fires around

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(a) The focus of the Section 4.9 discussion is currently available financial assurance mechanisms. As discussed in Sections 4.2 and 5.6, one or more newly-formed captive insurers are a very attractive alternative mechanism.

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1900, workers' compensation around 1910, mortgage insurance in the 1930s, automobile claim frequency about 1945, catastrophe property reinsurance after Hurricane Betsy in the early 1970s, and changes in tort laws about 1975 were all overcome.(a) In all of these cases, when established insurers could not or would not meet an essential insurance demand, the demand was met in some other way, usually by a new institution and often either by customers banding together or by a new insurance provider. It is possible that if coverage is really required, existing commercial insurers would find a way to assess the risks and provide the coverage. If they choose not to provide the needed coverage, a captive insurer appears to be a realistic alternative.

4.10 TIMING OF FUNDS AVAILABILITY

This report does not examine in detail the issue of how rapidly a particular financial assurance option could make cleanup funds available. However, this issue is potentially important in meeting the objectives of the ANPRM. One might think that a third party providing financial assurance would seek to make cleanup funds available as quickly as possible to minimize the extent of possible claims. In practice, a rapid response may in fact be the rule. There are, however, factors that potentially could slow the process. A surety company, for example, could delay payment on a performance bond until being convinced that the principal will not perform necessary cleanup activities. A somewhat related potential difficulty with CGL and EIL policies is that they are not typically written in terms of actual cleanup, but rather that the insurer will pay money on behalf of the insured which the insured becomes legally obligated to pay. Thus if the insured licensee voluntarily cleans up released radioactive materials, a recalcitrant insurer could perhaps claim that there is no liability under the policy because the policy does not cover cleanup activities, but only claims made against the insured.(b) Ideally, insurance policies that are used to satisfy a financial assurance requirement should provide that cleanup funds would be made available as soon as reasonably practicable.

4.11 CONCLUSIONS

Almost all of the existing financial assurance mechanisms under consideration by the NRC (with the possible exception of coverage under a CGL insurance policy) are potentially available to some of the licensees:

- EIL insurance may be available for some licensees from limited sources, although it is expected to be expensive.

(a) R. E. Stewart, "Coverage Always Happens . . . The Eighth Cycle is at Hand," National Underwriter Property & Casualty Insurance Edition, p. 31, March 21, 1986.

(b) See Section 4.1.

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- Surety bonds are available for activities the same as, or comparable to, those contemplated by the ANPRM, although terms may be unattractive. Surety bonds and standby letters of credit may be unavailable to licensees who are deemed poor credit risks.

- Conventional property insurance increasingly excludes contamination risk from radioactive materials, but coverage can still be obtained in some instances.

- The Price-Anderson nuclear insurance pools are limited in scope by their own policy constraints.

- Financial tests and corporate guarantees are potentially available for large, well-capitalized licensees.

- Licensees that appear to be the worst risks for surety bonds or standby letters of credit would also likely be the poorest risks for financial tests or corporate guarantees.

- Risk retention groups would be an attractive financial assurance mechanisms except for their limitation to providing liability coverage.

- Overall, over half of the licensees may have no access to surety bonds, standby letters of credit, or financial test/corporate guarantees.

It thus appears from the characteristics of the various mechanisms that the insurance option is the most logical financial assurance mechanism for the majority of licensees. Given the current disinterest of much of the commercial insurance industry in providing the needed coverage, it appears likely that coverage will need to come from one or more newly-formed captive insurers.

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5.0 DIRECT COSTS AND IMPACTS OF PROPOSED RULEMAKING TO LICENSEES

This section presents estimates of the direct costs of the proposed financial assurance rulemaking for licensees and assesses the impacts of these costs on the licensees' financial performance. Five alternative conventional financial assurance mechanisms are evaluated in Sections 5.1 and 5.2: 1) insurance from commercial property/casualty insurers, 2) surety bonds, 3) letters of credit, 4) escrow accounts, and 5) financial tests and corporate guarantees. Section 5.3 discusses specific impacts on licensees that qualify as small businesses under the NRC definition. Section 5.5 discusses approximate costs and impacts for the captive insurance company mechanism, which appears to be the preferred way to obtain financial assurance for most licensees. Finally, Section 5.6 discusses administrative costs to NRC and Agreement States associated with implementing the proposed rulemaking.

5.1 DIRECT COSTS OF CONVENTIONAL FINANCIAL ASSURANCE OPTIONS

This section addresses the direct costs of the conventional financial assurance mechanisms to the potentially affected licensees. The assumed costs of coverage of each of the five mechanisms are shown in Table 5.1.[a]

A mix of conventional financial assurance mechanisms currently seems most viable for most of the licensees (see Section 4.9). For the purpose of this section, we assume that the before-tax cost of conventional financial assurance for the average licensee would be $20/$1,000 of coverage. This assumption

TABLE 5.1. Assumed Annual Cost of Coverage for the Conventional Financial Assurance Mechanisms

Mechanism	Assumed Cost/Year	
	Before Tax	After Tax
Insurance Policy	$30/$1000 coverage	$19.80/$1000 coverage
Surety Bond	$20/$1000 coverage	$13.20/$1000 coverage
Standby Letter of Credit	$15/$1000 coverage	$ 9.90/$1000 coverage
Escrow Account	$50/$1000 coverage	$33.00/$1000 coverage
Financial Test/Corporate Guarantee	$300-$500 licensee	$300/licensee
Assumed Composite Mix	$20/$1000 coverage	$13.20/$1000 coverage

(a) The before-tax cost estimates are documented in Section 4. The after-tax costs are calculated assuming a corporate tax rate of 34%. The Tax Reform Act of 1986 established the new 34% rate effective July 1, 1987 for taxable corporate income over $75K. Income under $50K is taxed at 15%. Income between $50K and $75K is taxed at a 25% rate.

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corresponds well with estimates provided in comment letters on the ANPRM, comments submitted to EPA on the availability of EIL insurance for hazardous waste sites, and results of the research conducted for this report. We also assumed that the cost of the financial assurance mechanisms would be a deductible expense for the purpose of computing federal income taxes and that the cost increases linearly with the dollar level of coverage. Estimates of the direct costs of increased insurance coverage were prepared for two coverage scenarios: $2M blanket coverage for all licensees, and the sliding scale of coverage shown in Table 1.2.

5.1.1 Current Financial Assurance Costs

No estimate was prepared for current financial assurance costs paid by the licensees covered by the ANPRM. The principal reason is that the total number of licensees with such coverage is unknown, although it is unlikely to be high because of industry reluctance to provide coverage and the inability of licensees to qualify for coverage (see Section 4 and Appendix A). Several licensees who commented on the ANPRM indicated lack of coverage, loss of coverage, or insurance industry unwillingness to provide coverage for radioactive hazards under comprehensive general liability insurance.(a) A few commenters indicated that they believed they were covered by either insurance or surety bonds for related activities such as decommissioning.(b) The number of covered licensees may also be declining because of the adverse trends in EIL and CGL coverage discussed in Section 4.1. Offsetting any such decline would be increased Agreement State activity. At least three Agreement States--Florida, New York, and Tennessee--do require some form of financial assurance from their higher-risk licensees (Section 3.2.5), but the total cost of this coverage to industry is also unknown.

5.1.2 Total Financial Assurance Costs to Licensees

This section discusses the total after-tax cost to licensees of a composite of financial assurance mechanisms and of each individual mechanisms shown in Table 5.1.

5.1.2.1 Composite of Financial Assurance Mechanisms

The direct cost of financial assurance to the affected licensees would depend on which financial assurance mechanisms are actually adopted. Commercial insurance is the most likely conventional option for a majority of firms because the size of required coverage will likely place most other mechanisms

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(a) Letter comments on the ANPRM from Atomic Energy of Canada, Ltd. October 5, 1985; Thermo-Scan Engineering, Inc., November 4, 1985; Massachusetts Materials Research, Inc., September 27, 1985; Fred S. James and Co., September 11, 1985; X-Ray, Inc., September 27, 1985; and Carpenter Technology Corp., September 19, 1986.

(b) E.g., letter comments on the ANPRM from Oklahoma Testing Laboratories, July 30, 1985; Hecla Mining Co., August 22, 1985; and Trapper Mining, Inc., October 4, 1985.

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out of reach of the majority of licensees. Nevertheless, it is an expensive option. In actual practice it is likely that a mix of mechanisms will be adopted. No objective basis exists for determining what this mix would be, although Section 4.10 shows that smaller licensees likely would probably only have access to escrow or commercial insurance while larger licensees would be more likely to qualify for surety bonds, standby letters of credit, and financial tests. We have assumed a value of $20/$1,000 ($13.20/ $1000 after taxes) of coverage to licensees of all size classes, corresponding to a mix of mechanisms. This cost reflects the assumption that some licensees would utilize more expensive insurance and escrow options, while others would utilize surety bonds, standby letters of credit, and financial tests. Coincidentally, the assumed cost is the same cost as estimated for surety bonds. The total cost of this mix of mechanisms to affected licensees is shown in Table 5.2.

At an average assumed rate of $20/$1,000, Table 5.2 shows that after-tax costs for a blanket $2M in coverage would be about $430M/yr for all affected licensees. The largest portion of these costs would be incurred by those licensees that are involved in measurement, calibration, or irradiation. With blanket $2M coverage, all categories of licensees in Table 5.2 would incur the same costs--about $26,400/yr. If the smaller licensees are more likely to use commercial insurance or escrow accounts and the larger licensees are more likely to use surety bonds, standby letters of credit, and financial tests, then Table 5.2 understates the costs to small licensees and overstates the costs to large licensees.(a)

With sliding scale coverage, the total after-tax cost of coverage with the assumed mix of financial assurance instruments is about $100M, or about 1/4 the cost of blanket coverage. This may overstate the relative costs to industry of sliding scale coverage compared with blanket coverage. With lower coverage requirements for some smaller licensees, it may be possible for more of them to qualify for the less expensive financial assurance mechanisms than if blanket $2M coverage were required.

The remainder of this subsection estimates the costs of coverage for each financial mechanism as if it were the only one utilized, to demonstrate how total cost would vary. The direct cost impacts would be expected to be about the same as the cost for a mix of mechanisms for surety bonds, 25% less for standby letters of credit, 1.5 times more expensive for commercial insurance, about 2.5 times more expensive for escrow accounts, and only about 1% as expensive for financial tests or corporate guarantees.

5.1.2.2 Commercial Insurance From a Property/Casualty Insurer

At an assumed rate of $30/$1,000 ($19.80/$1000 after tax), the cost of insurance from a commercial property/casualty insurer for a blanket $2M coverage per licensee would total approximately $650M/yr after taxes for all

(a) Using the assumptions in Table 4.3, the weighted average cost of coverage is $23/$1,000 for blanket $2M coverage and $22/$1,000 for sliding scale coverage.

TABLE 5.2. After-Tax Annual Cost of Conventional Financial Assurance Coverage to Material Licensees[a]

Category of Licensee	Number of Licensees[b]	Total Cost/Yr for $2M Coverage	Amount of Sliding Scale Coverage per Licensee[c]	Cost/Yr for Sliding Scale Coverage[c]	Cost/Yr/Licensee for Sliding Scale Coverage
I. Research, Teaching, Diagnostic, Therapy					
a. Less than 0.1 Curie	3,498	$ 92,300,000	$ 100,000	$ 4,600,000	$ 1,320
b. 0.1 to 1 Curie	1,116	29,500,000	250,000	3,700,000	3,300
c. 1 to 10 Curies	1,772	46,800,000	500,000	11,700,000	6,600
d. 10 to 100 Curies	372	9,800,000	1,000,000	4,900,000	13,200
e. More than 100 Curies	531	14,000,000	2,000,000	14,000,000	26,400
II. Measurement, Calibration, Irradiation					
a. Less than 0.1 Curie	4,151	$109,600,000	$ 100,000	$ 5,500,000	$ 1,320
b. 0.1 to 1 Curie	1,486	39,200,000	250,000	4,900,000	3,300
c. 1 to 10 Curies	1,089	28,800,000	500,000	7,200,000	6,600
d. 10 to 100 Curies	346	9,100,000	1,000,000	4,600,000	13,200
e. More than 100 Curies	1,181	31,200,000	2,000,000	31,200,000	26,400
III. Manufacture and Distribution					
a. Less than 0.1 Curie	228	$ 6,000,000	$ 100,000	$ 300,000	$ 1,320
b. 0.1 to 1 Curie	162	4,300,000	250,000	500,000	3,300
c. 1 to 10 Curies	129	3,400,000	500,000	900,000	6,600
d. 10 to 100 Curies	161	4,300,000	1,000,000	2,100,000	13,200
e. More than 100 Curies	66	1,700,000	2,000,000	1,700,000	26,400
IV. Waste Processing and Storage	33	$ 900,000	$2,000,000	$ 900,000	$26,400
V. Fuel Cycle	28	$ 700,000	$2,000,000	$ 700,000	$26,400
Total	16,349	$431,600,000		$99,400,000	

(a) Based on a before-tax cost of $20/$1000 of coverage, corresponding to an after-tax cost of $13.20/$1,000 of coverage.
(b) See Appendix C for the number of licensees by category.
(c) NRC's tentative risk-based sliding scale is shown in Table 1.2.

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affected licensees. The largest total cost for insurance premiums would occur for those licensees that are involved in measurement, calibration, and irradiation due to the number of licensees involved in this activity. Since the level of required coverage is the same for all categories of licensees under this scenario, the premiums are the same for each licensee--$60,000/yr.

The total insurance cost for all categories of affected licensees for the sliding scale scenario is approximately $150M/yr, or about 1/4 of the total cost of the blanket coverage scenario. The major impact of the sliding scale scenario is on those licensees that are involved in measurement calibration and irradiation and are handling more than 100 curies.

Since the amount of coverage required by the sliding scale scenario varies from one category of licensee to another, individual premiums are not the same for all licensees. The largest premiums would be paid by those licensees authorized to handle more than 100 curies in any of the first three categories of licensees in Table 5.2, or those involved in waste processing and storage or fuel cycle activities.

5.1.2.3 Surety Bonds

A second financial mechanism potentially available to licensees to demonstrate financial assurance is a surety bond. For this estimate it was assumed that the cost of these bonds would be about $20/$1,000 ($13.20/$1000 after taxes) per year of coverage. The total costs to all affected licensees of purchasing surety bonds for $2M blanket coverage would be about $430M/yr after taxes. The direct financial impact on individual licensees would be distributed similarly to that of the increased premiums from purchasing an insurance policy.

The total costs to affected licensees of purchasing a surety bond based on the sliding scale scenario would be about 2/3 of the cost of commercial insurance, or approximately $100M/yr. Again, the impact on individual licensees of purchasing a surety bond for the sliding scale scenario would be similar to the impact of buying an insurance policy.

5.1.2.4 Standby Letters of Credit

The third financial responsibility option potentially available to materials licensees under the ANPRM is the standby letter of credit. Standby letters of credit would operate similarly to surety bonds. Payment would be made by the issuing bank in the event that cleanup of an accidental release of radioactive materials was not paid for by the licensee.

Qualifications for obtaining a standby letter of credit are similar to the qualifications for receiving a loan. The annual fee charged for a standby letter of credit varies from bank to bank, but averages 1 1/2% of the value of

the letter.[a] Thus, the total after-tax cost of purchasing a standby letter of credit for the $2M blanket coverage scenario for affected licensees would be about $320M/yr. The total cost, assuming the sliding scale scenario, would be about $74M/yr.

5.1.2.5 Escrow Accounts

The fourth financial responsibility mechanism potentially available to licensees is to place funds equal to the amount of required coverage into an escrow account. In the case of an accident, money from this account would be used to pay for cleanup costs. The yield of an escrow account depends upon the length of maturity and the level of liquidity. Since it is unknown when an accident will occur, and since the account needs to be fairly liquid, a flexible rate escrow account was chosen for this analysis. In a flexible rate account, the interest rate paid fluctuates from week to week; however, money can be withdrawn almost immediately. Flexible rate escrow accounts in late 1986 paid about 6% interest.

It can be assumed that most materials licensees reinvest at least a portion of their earnings back into their business. However, a materials licensee complying with the financial assurance rule by using an escrow account would be forced to place a part of his earnings or capital into a highly liquid escrow account. Placement of these funds into the escrow account is a cost to the licensee that is represented by the difference between the potential return on equity from reinvestment in his business and the lower return from the escrow account.

The expected rate of return on equity is difficult to observe directly. Corporate bonds were chosen as the lower-bound proxy for the rate of return on equity available to a materials licensee, since most licensees would hope to earn more than this rate of return if they are investing in their firms rather than the bond market. Baa bonds were chosen since these bonds have a higher risk and yield a greater return than AAA bonds. They are consequently more reflective of the rate of return on equity for smaller companies, which include most materials licensees. In 1986 the interest rate on Baa bonds was about 10.5%.[b] Thus, the difference between the yield on the longer term, less liquid investment and the yield on the escrow account is approximately 4.5%. Allowing for trust fees and administrative charges, a licensee is estimated to

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(a) Personal communication with Richard Clark, First Interstate Bank, Portland, OR, March 28, 1986. There is considerable variation in this cost, among banks, as described in Section 4.5.

(b) "U.S. Financial Data," March 6, 1986, Federal Reserve Bank of St. Louis, P.O. Box 442, St. Louis, MO 63166.

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be losing about 5% per annum on the money that is placed into a money market escrow account versus a longer-term asset.[a]

This loss of 5% represents a cost of $50/$1,000 ($33/$1,000 after taxes) for an escrow account. The direct costs of this option based on $2M coverage would be about $1,000M/yr after taxes. If the sliding scale scenario were used, the total cost of an escrow account would be $250M/yr. In both the $2M blanket rate and the sliding scale scenarios, the impact on the individual categories of licensees would be distributed similarly to the impacts of the commercial insurance policy.

5.1.2.6 Financial Test/Corporate Guarantee

The fifth financial responsibility mechanism potentially available to materials licensees is the financial test/corporate guarantee. The costs of this mechanism to the licensee are primarily administrative costs that include review of corporate financial records by accounting and legal staff. It is unlikely that the cost of this mechanism would increase with the amount of coverage. The after-tax cost of this mechanism is estimated to be $300/yr/licensee, representing a total cost of about $5M for both the $2M blanket coverage and sliding scale scenarios.

5.2 IMPACTS ON LICENSEE PROFITABILITY

If licensees are required to show financial assurance for cleanup of radioactive materials releases with existing conventional mechanisms, the cost may have a substantial impact on the profitability and in some cases the survival of the firms. The cost of using one or more newly-formed captive insurers could be significantly less, as discussed in Section 5.6. Several commenters on the ANPRM mentioned that if the proposed requirement were to be adopted, the commenter could be forced out of business, forced to drop those activities depending on the licensed radioactive source, or forced to substantially increase prices to cover the increased cost of doing business. The significance of the cost impact could be considerably different for a large enterprise than for a small one. The purpose of this section is to show how the impacts would vary for different types and sizes of enterprises. For each size class we determined 1) the percentage of the average licensee's annual net (after tax) income represented by the annual financial assurance cost, 2) the effect on return on assets if the cost were to be absorbed by the licensee, 3) the necessary increase in sales volume at no increase in price (net of cost of sales and operations) that would be required to offset the increase in cost, and 4) the price increase for the licensee's product with no increase in sales

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(a) If the licensee is forced to borrow funds solely to maintain the escrow account and the expected rate of return in his business is less than the borrowing rate, there may be an additional cost of borrowing equal to the difference between the rate at which he borrows and the (lower) rate of return he could expect from investing those borrowed funds in his business. Thus, 5% per annum may be conservative.

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volume that would be required to offset the costs related to the financial assurance requirement. All of the analysis in Section 5.2 assumes a before-tax composite financial assurance cost of $20/$1,000 of coverage or $13.20/$1,000 of coverage after taxes.

In assessing impacts on licensee profitability, we examined four size classes of firms based on annual sales. Table 5.3 shows the estimated number of licensees who fall into each sales size classification, by licensee category, under the sliding scale coverage shown in Table 1.2. The number of firms in each classification was derived from the responses to the 1983 DRR survey, with the dollar volumes updated to 1985 dollars (see Appendix C).

Table 5.4 shows the potential direct annual financial cost to the licensees for cleanup, stated as a percentage of estimated net after-tax annual income. As noted above, a mix of mechanisms is assumed at a cost of $20/$1,000 of coverage. Entries showing "loss" occur because firms in this sales category showed a loss in the IRS 1985 publication for the period July, 1982, to June, 1983. As discussed in Section 4.10, small firms are more likely to have to resort to more expensive options, while large firms are more likey to obtain financial guarantees or surety bonds. Table 5.4 thus probably understates the impact on small firms and overstates the impact on large ones. No net income

TABLE 5.3. Number of Licensees Affected by the Proposed Rulemaking by Category of Licensee and Annual Sales

Category of Licensee	Annual Sales			
	< $1M	$1M to $5M	$5M to $25M	> $25M
I. Research, Teaching, Diagnostic, Therapeutic				
a. Less than 0.1 Curie	1056	404	787	1251
b. 0.1 to 1 Curie	337	129	251	399
c. 1 to 10 Curies	535	204	398	634
d. 10 to 100 Curies	112	43	84	133
e. More than 100 Curies	160	61	120	190
II. Measurement, Calibration, Irradiation				
a. Less than 0.1 Curie	1357	767	656	1371
b. 0.1 to 1 Curie	485	275	235	491
c. 1 to 10 Curies	356	201	172	360
d. 10 to 100 Curies	113	64	55	114
e. More than 100 Curies	386	218	187	390
III. Manufacturing and Distribution				
a. Less than 0.1 Curie	48	48	37	95
b. 0.1 to 1 Curie	34	34	26	68
c. 1 to 10 Curies	27	27	21	54
d. 10 to 100 Curies	34	34	26	67
e. More than 100 Curies	14	14	11	27
IV. Waste Processing and Storage	10	10	13	0
V. Fuel Cycle	4	8	3	13
Total	5068	2541	3083	5657

Source: See Appendix C.

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TABLE 5.4. After-Tax Cost of Cleanup Financial Assurance as a Percentage of Estimated Net After-Tax Annual Income, by Category of Licensee and Annual Sales

Category of Licensee	Blanket $2 Million Coverage (%)			Risk-Based Sliding Scale Coverage (%)		
	$1M	$7M	$25M	$1M	$7M	$25M
I. Research, Teaching, Diagnostic, Therapeutic						
a. Less than 0.1 Curie	Loss	458	61	Loss	22	3.1
b. 0.1 to 1 Curie	Loss	458	61	Loss	57	7.7
c. 1 to 10 Curies	Loss	458	61	Loss	114	15
d. 10 to 100 Curies	Loss	458	61	Loss	229	31
e. More than 100 Curies	Loss	458	61	Loss	458	61
II. Measurement, Calibration, Irradiation						
a. Less than 0.1 Curie	302	23	5.4	15	1.2	0.3
b. 0.1 to 1 Curie	302	23	5.4	38	2.9	0.7
c. 1 to 10 Curies	302	23	5.4	75	5.8	1.3
d. 10 to 100 Curies	302	23	5.4	151	12	2.7
e. More than 100 Curies	302	23	5.4	302	23	5.4
III. Manufacturing and Distribution						
a. Less than 0.1 Curie	182	14	3.1	9.1	0.7	0.2
b. 0.1 to 1 Curie	182	14	3.1	23	1.7	0.4
c. 1 to 10 Curies	182	14	3.1	46	3.5	0.8
d. 10 to 100 Curies	182	14	3.1	91	7.0	1.5
e. More than 100 Curies	182	14	3.1	182	14	3.1
IV. Waste Processing and Storage	209	27	7.0	209	27	7.0
V. Fuel Cycle	Loss	Loss	4.1	Loss	Loss	4.1

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figures are directly available for licensees, so net income was estimated from IRS industry statistics of income for corporate tax returns filed for the 1982 and 1983 tax years (see Section 4.7).[a] We selected the firms in the IRS asset size class that had gross sales that most closely matched the DRR sales size classes.

The categories of firms for which IRS financial statistics are available are broader than the specific businesses in which the licensees may participate or for which they may require a radioactive materials license; however, no data are available on the profitability of individual lines of business for which materials licenses are required. In preparing Table 5.4, we assumed that the financial size of the licensee is independent of the curies of radioactive material in his possession. Thus, research, teaching, diagnostic, and therapeutic licensees with less than 0.1 curie per source were assumed to be distributed across all sizes of firms in the same proportions as all DRR-surveyed firms in the research, teaching, diagnostic and therapeutic category. No data were available to permit more precise matching of type of licensee and amount of radioactive material with the licensee's financial size.

Table 5.4 shows the cost impacts of the assumed mix of financial assurance mechanisms as a percentage of net after-tax income for materials licensees covered by the ANPRM, divided into the categories shown in Table 1.2. The percentage in each set of three columns is the annual after-tax cost per licensee divided by estimated net after-tax income per return for the size class of firm defining the column. For example, the first entry is $26,400 (the annual after-tax cost for $2M coverage) divided by the average after-tax income per firm for those firms with approximately $1M in sales. The first three columns describe the impact of the financial obligation for a blanket $2M coverage for every licensee. The next three columns show the cost as a percentage of net after-tax income for the risk-based sliding scale coverage shown in Table 1.2.

Table 5.4 does not include the financial assurance costs for the status quo alternative, i.e., no NRC financial assurance rule. A few Agreement States currently have financial assurance requirements and some firms may have financial assurance mechanisms regardless of regulatory requirements (see Section 3); however, it is assumed for this analysis that such situations are already reflected in the average net income figures for each industry. Consequently, there would be no net effect on industry income if the rule is not imposed by NRC. Adoption of NRC financial assurance requirements in those Agreement States that have existing financial assurance rules should not have as large a percentage effect on income as in states where no rule exists. In addition, there would be a smaller increase in costs of doing business than in

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(a) IRS 1985. Comparable data were not available to determine rate of return on assets for individual tax returns and partnerships. Therefore, we could not determine whether income as a percent of assets on sole proprietorship and partnership returns was higher or lower than for corporate returns.

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other states; however, the net income for a given level of sales would also be smaller by the annual cost of the existing state financial assurance rule.[a]

The entries in Table 5.4 indicate that the blanket $2M requirement would create a substantial burden for all but the largest licensees. (Large licensees may also be burdened--see Section 5.5.) For example, the increase in costs for financial assurance coverage ranges from 458% of net after-tax income in the smallest sales category of research, teaching, diagnostics and therapeutics at the $2M coverage level to 3.1% in the manufacturing and distribution category with $25M annual sales. The impact for the sliding scale coverage is less easily described; however, it appears that smaller firms would still experience a significant impact.

Another way to estimate the impact of the financial assurance rule is shown in Table 5.5. In this table, the licensees' estimated net after-tax income is reduced by the annual cost of financial assurance. Return on assets (net after-tax income divided by the value of assets) is then computed both with and without a financial assurance rule. The assumption used to prepare Table 5.5 represents an extreme case, because in practice it is likely that some of the incremental financial assurance costs could be passed on to the licensees' clients. Table 5.5 shows that for smaller firms in particular, the additional costs imposed by the financial assurance requirements would significantly lower rate of return on assets and could be difficult to absorb. For example, for licensees in the category of measurement, calibration and irradiation with $7M in sales, the existing after-tax rate of return on assets is lowered by the assumed $40,000 annual cost for a $2M blanket financial assurance obligation from 2.5% to 1.9%. Sliding scale coverage for the same category has only a minimal effect on the rate of return.

The results shown in Tables 5.4 and 5.5 tend to confirm the concerns of several small firms that commented on the ANPRM that the potential financial impact would be substantial. However, a significant factor in determining whether net after-tax income would be actually reduced is whether revenues could be increased to cover the cost of new financial assurance requirements (see also Section 5.5). Such an increase might be accomplished if the firm increased prices, increased sales volume by additional sales effort, or both.

Table 5.6 shows the financial impact on licensees in yet another way by indicating the percentage increase in sales volume (at no increase in price)

(a) Compare two identical radiography licensees with annual sales of $1M. Assume the Agreement State firm's license has a financial responsibility requirement costing $10,000 per year and that the proposed rule would increase this cost to $15,000. Assume further that all other costs equal $900,000. The second firm, in a state having no financial responsibility requirement, would have the same sales and the same costs except for financial responsibility. For the Agreement State firm, the increase in costs as a percent of net income would be ($15,000-$10,000) ($1,000,000-$900,000-$10,000), or 5.6%. For the other firm, the increase would be ($15,000)/($1,000,000-$900,000), or 15%.

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TABLE 5.5. Effect of the After-Tax Cost of Financial Assurance Requirements on Return on Assets, by Category of Licensee and Annual Sales

Category of Licensee	Blanket $2 Million Coverage						Sliding Scale Coverage					
	$1M Sales		$7M Sales		$25 Sales		$1M Sales		$7M Sales		$25M Sales	
	Return Without Rule	Return With Rule	Return Without Rule	Return With Rule	Return Without Rule	Return With Rule	Return Without Rule	Return With Rule	Return Without Rule	Return With Rule	Return Without Rule	Return With Rule
I. Research, Teaching, Diagnostic, Therapeutic												
a. Less than 0.1 Curie	Loss	Loss	0.3%	Loss	0.2%	0.1%	Loss	Loss	0.3%	0.2%	0.2%	0.2%
b. 0.1 to 1 Curie	Loss	Loss	0.3	Loss	0.2	0.1	Loss	Loss	0.3	0.1	0.2	0.2
c. 1 to 10 Curies	Loss	Loss	0.3	Loss	0.2	0.1	Loss	Loss	0.3	Loss	0.2	0.2
d. 10 to 100 Curies	Loss	Loss	0.3	Loss	0.2	0.1	Loss	Loss	0.3	Loss	0.2	0.1
e. More than 100 Curies	Loss	Loss	0.3	Loss	0.2	0.1	Loss	Loss	0.3	Loss	0.2	0.1
II. Measurement, Calibration, Irradiation												
a. Less than 0.1 Curie	1.7%	Loss	2.5%	1.9%	2.6%	2.5%	1.7%	1.4%	2.5%	2.5%	2.6%	2.6%
b. 0.1 to 1 Curie	1.7	Loss	2.5	1.9	2.6	2.5	1.7	1.1	2.5	2.4	2.6	2.6
c. 1 to 10 Curies	1.7	Loss	2.5	1.9	2.6	2.5	1.7	0.4	2.5	2.4	2.6	2.6
d. 10 to 100 Curies	1.7	Loss	2.5	1.9	2.6	2.5	1.7	Loss	2.5	2.2	2.6	2.6
e. More than 100 Curies	1.7	Loss	2.5	1.9	2.6	2.5	1.7	Loss	2.5	1.9	2.6	2.5
III. Manufacturing and Distribution												
a. Less than 0.1 Curie	3.4%	Loss	2.8%	2.4%	5.8%	5.6%	3.4%	3.1%	2.8%	2.8%	5.8%	5.8%
b. 0.1 to 1 Curie	3.4	Loss	2.8	2.4	5.8	5.6	3.4	2.6	2.8	2.8	5.8	5.8
c. 1 to 10 Curies	3.4	Loss	2.8	2.4	5.8	5.6	3.4	1.8	2.8	2.7	5.8	5.7
d. 10 to 100 Curies	3.4	Loss	2.8	2.4	5.8	5.6	3.4	0.3	2.8	2.6	5.8	5.7
e. More than 100 Curies	3.4	Loss	2.8	2.4	5.8	5.6	3.4	Loss	2.8	2.4	5.8	5.6
IV. Waste Processing and Storage	2.1%	Loss	1.7%	1.2%	1.6%	1.5%	2.1%	Loss	1.7%	1.2%	1.6%	1.5%
V. Fuel Cycle	Loss	Loss	Loss	Loss	1.3%	1.2%	Loss	Loss	Loss	Loss	1.3%	1.2%

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TABLE 5.6. Percent Increase in Sales Volume Required to Maintain After-Tax Net Income of Licensees, by Category of Licensee and Annual Sales

Category of Licensee	Blanket $2 Million Coverage Annual Sales ($)			Sliding Scale Coverage Annual Sales ($)		
	$1M	$7M	$25M	$1M	$5M	$25M
I. Research, Teaching, Diagnostic, Therapeutic						
a. Less than 0.1 Curie	5.5	0.7	0.2	0.3	0.04	0.01
b. 0.1 to 1 Curie	5.5	0.7	0.2	0.7	0.1	0.03
c. 1 to 10 Curies	5.5	0.7	0.2	1.4	0.2	0.05
d. 10 to 100 Curies	5.5	0.7	0.2	2.7	0.4	0.1
e. More than 100 Curies	5.5	0.7	0.2	5.5	0.7	0.2
II. Measurement, Calibration, Irradiation						
a. Less than 0.1 Curie	0.6	1.8	0.5	0.5	0.1	0.03
b. 0.1 to 1 Curie	9.6	1.8	0.5	1.2	0.2	0.1
c. 1 to 10 Curies	9.6	1.8	0.5	2.4	0.4	0.1
d. 10 to 100 Curies	9.6	1.8	0.5	4.8	0.9	0.3
e. More than 100 Curies	9.6	1.8	0.5	9.6	1.8	0.5
III. Manufacturing and Distribution						
a. Less than 0.1 Curie	13.4	1.5	0.4	0.7	0.1	0.02
b. 0.1 to 1 Curie	13.4	1.5	0.4	1.7	0.2	0.1
c. 1 to 10 Curies	13.4	1.5	0.4	3.4	0.4	0.1
d. 10 to 100 Curies	13.4	1.5	0.4	6.7	0.8	0.2
e. More than 100 Curies	13.4	1.5	0.4	13.4	1.5	0.4
IV. Waste Processing and Storage	6.7	1.2	0.4	6.7	1.2	0.4
V. Fuel Cycle	41.7	1.4	0.5	41.7	1.4	0.5

that would be required to restore net income to its pre-existing level if the financial assurance rule were adopted. Table 5.6 assumes an increase in sales volume with a proportional increase in cost of sales. This is roughly equivalent to assuming that competitive pressure in the marketplace keeps the licensee from passing on cost increases in the form of higher prices. It may be possible for individual licensees to expand the volume of goods and services they make or deliver. However, economic theory suggests that it probably would not be possible for the whole industry to expand production at once, since the market could not absorb the increased output without either an increase in demand or reduction in price. Unless the volume of goods and services demanded from licensees simultaneously increases, the long-term result of the increase in cost would have to be a reduction in net income for existing operators or a decrease in their numbers. Thus, Table 5.6 describes an artificial case in the short term. However, the percentages shown in Table 5.6 indicate that in the short term at least, small licensees would have to substantially increase their sales volume to maintain net income in the context of the proposed financial responsibility rule. At annual sales levels above $7M, the effect of increased annual costs for even $2M coverage could be covered by very minor increases in sales volume.

The licensees' other main option to maintain income while continuing to provide service is to increase price. Review of the comments received by NRC on the ANPRM suggests that most radioactive materials licensees operate in

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industries that are highly competitive in terms of service and price. However, there is little indication from the comments that alternative technologies are widely used or are closely cost-competitive with radioactive materials for providing these services. It may be possible, therefore, for some licensees to fully reflect financial assurance requirements in incremental price increases. Table 5.7 shows the extent to which average price of output would have to increase in order to maintain net income.[a] Again, the major negative impact would be on the firms in the smallest sales categories. Assuming that large and small firms are currently price competitive with each other, a possible effect of the necessary price increase could be to force many small firms having less than $1M annual sales out of business. For example, with $2M blanket coverage, Table 5.7 shows that firms having $1M annual sales would have to increase price by 4.0% to cover additional financial assurance costs, while their competitors having $7M annual sales or more would have to increase prices by less than 1%. If consumers are currently indifferent between large and small firms, the effect of the cost increase could be to jeopardize the competitive position of the smaller firms.

5.3 IMPACTS ON SMALL BUSINESSES

The Regulatory Flexibility Act of 1980[b] requires federal agencies to analyze the economic impact of a proposed rule on small entities if the rule would significantly affect a substantial number of such entities. NRC has

TABLE 5.7. Percent Increase in Average Prices Required to Maintain Net After-Tax Income of Licensees, by Category of Licensee and Annual Sales

Category of Licensee	Blanket $2 Million Coverage — Annual Sales ($1M)	Blanket $2 Million Coverage — Annual Sales ($7M)	Blanket $2 Million Coverage — Annual Sales ($25M)	Sliding Scale Coverage — Annual Sales ($1M)	Sliding Scale Coverage — Annual Sales ($7M)	Sliding Scale Coverage — Annual Sales ($25M)
For Category I, II, III:						
a. Less than 0.1 Curie	4.0	0.6	0.2	0.2	0.03	0.008
b. 0.1 to 1 Curie	4.0	0.6	0.2	0.5	0.1	0.02
c. 1 to 10 Curies	4.0	0.6	0.2	1.0	0.1	0.04
d. 10 to 100 Curies	4.0	0.6	0.2	2.0	0.3	0.1
e. More than 100 Curies	4.0	0.6	0.2	4.0	0.6	0.2
For Category IV, V	4.0	0.6	0.2	4.0	0.6	0.2

(a) A general increase in price, however, should result in reduced quantity of services demanded, which could reduce total industry income.
(b) Public Law No. 96-354, 5 U.S.C. 601-612.

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determined that such an analysis, when required, should be incorporated into the analysis prepared under NRC's Regulatory Analysis Guidelines.(a)

In December 1985 NRC adopted size standards for entities to be considered small businesses for purposes of the Regulatory Flexibility Act.(b) These NRC size standards:

- For most licensees, annual billings of $3.5M or less
- For private practice physicians, annual billings of $1M or less
- For state or public educational institutions, an institution supported by a jurisdiction with a population of 50,000 or less
- For other educational institutions, an institution having 500 or fewer employees.

The 1983 DRR Survey did not anticipate the size standard eventually adopted by the NRC. Thus, it was not possible to obtain an accurate count of small entities conforming to the current definition. However, an estimate of impact was prepared for entities meeting the definition of small businesses by dividing the DRR $1-7M billings category at $3.5M.(c) The results are shown in Table 5.8. Educational institutions and private practice physicians could not be readily identified and classified for separate analysis. However, about 92% of private practice physicians responding to the DRR Survey in 1983 are known to have reported billings of $1M or less. For physicians, use of the $3.5M size standard in Table 5.8 would likely understate the impact on small business since the $3.5M standard would include physicians who are not small businesses and for whom the impacts are proportionately smaller. Therefore, the weighted average financial impacts for the research, teaching, diagnostic, and therapeutic category in Table 5.8 were adjusted to reflect the use of a $1M size standard for physicians. About one-third of educational institutions are actually small businesses under the current NRC standards. It is likely, because of the level of average faculty and staff salaries, that most educational institutions having 500 employees would have annual billings above $3.5M. Thus, the use of the $3.5M standard in Table 5.8 may overstate the effect of the financial assurance rule on this type of small entity by describing the impacts on the smallest of them. However, no adjustment could be made to correct for this overstatement of impact.

Table 5.8 shows the cost of financial assurance to small businesses for $2M blanket coverage and sliding scale coverage at the $3.5M and $0.5M sales levels assuming a cost of $20/$1000 of coverage. At $3.5M sales with $2M

(a) Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission, NUREG/BR-0058 Revision 1, Appendix B, May 1984.

(b) 50 Federal Register 50241, December 9, 1985.

(c) The data in IRS 1985 were again used to estimate the impact on small businesses since financial statistics were not available for the licensees themselves.

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TABLE 5.8. Effects of the Cost of Financial Assurance Requirements on Small Businesses with $3.5M and $0.5M Annual Sales

Category of Licensee	Estimated Number of Small Entities		Percent Existing After-Tax Return on Assets		$2M Blanket Coverage						Sliding Scale Coverage					
					Percent Return on Assets if Cost Absorbed		Percent Increase in Sales Volume Required to Maintain Net Income		Percent Increase in Price Required to Maintain Net Income		Percent Return on Assets if Cost Absorbed		Percent Increase in Sales Volume Required to Maintain Net Income		Percent Increase in Price Required to Maintain Net Income	
	Sales <$3.5M	Sales <$0.5M	$3.5M	$0.5M	$3.5M	$0.5M	$3.5M	$0.5M	$3.5M	$0.5M	$3.5M	$0.5M	$3.5M	$0.5M	$3.5M	$0.5M
I. Research, Teaching, Diagnostic, Therapeutic																
a. Less than 0.1 Curie	1,217[a]	503	0.1[a]	Loss	Loss	Loss	1.7[a]	11	1.2[a]	8.0	Loss	Loss	0.1[a]	0.5	0.1	0.4
b. 0.1 to 1 Curie	389[a]	160	0.1[a]	Loss	Loss	Loss	1.7[a]	11	1.2[a]	8.0	Loss	Loss	0.2[a]	1.3	0.2	1.0
c. 1 to 10 Curies	617[a]	255	0.1[a]	Loss	Loss	Loss	1.7[a]	11	1.2[a]	8.0	Loss	Loss	0.4[a]	2.7	0.3	2.0
d. 10 to 100 Curies	129[a]	53	0.1[a]	Loss	Loss	Loss	1.7[a]	11	1.2[a]	8.0	Loss	Loss	0.8[a]	5.4	0.6	4.0
e. More than 100 Curies	184[a]	76	0.1[a]	Loss	Loss	Loss	1.7[a]	11	1.2[a]	8.0	Loss	Loss	1.7[a]	11	1.2	8.0
	2,536	1,047														
II. Measurement, Calibration, Irradiation																
a. Less than 0.1 Curie	1,664	646	1.4	Loss	Loss	Loss	3.3	17	1.1	8.0	1.3	Loss	0.2	0.8	0.1	0.4
b. 0.1 to 1 Curie	595	231	1.4	Loss	Loss	Loss	3.3	17	1.1	8.0	1.2	Loss	0.4	2.1	0.1	1.0
c. 1 to 10 Curies	436	169	1.4	Loss	Loss	Loss	3.3	17	1.1	8.0	1.0	Loss	0.8	4.2	0.3	2.0
d. 10 to 100 Curies	139	54	1.4	Loss	Loss	Loss	3.3	17	1.1	8.0	0.7	Loss	1.7	8.5	0.6	4.0
e. More than 100 Curies	473	184	1.4	Loss	Loss	Loss	3.3	17	1.1	8.0	Loss	Loss	3.3	17	1.1	8.0
	3,307	1,284														
III. Manufacturing and Distribution																
a. Less than 0.1 Curie	67	23	4.7	Loss	3.4	Loss	3.0	16	1.1	8.0	4.7	Loss	0.2	0.8	0.1	0.4
b. 0.1 to 1 Curie	48	16	4.7	Loss	3.4	Loss	3.0	16	1.1	8.0	4.6	Loss	0.4	2.0	0.1	1.0
c. 1 to 10 Curies	38	13	4.7	Loss	3.4	Loss	3.0	16	1.1	8.0	4.4	Loss	0.8	3.9	0.3	2.0
d. 10 to 100 Curies	48	16	4.7	Loss	3.4	Loss	3.0	16	1.1	8.0	4.1	Loss	1.5	7.9	0.6	4.0
e. More than 100 Curies	19	7	4.7	Loss	3.4	Loss	3.0	16	1.1	8.0	3.4	Loss	3.0	16	1.1	8.0
	220	75														
IV. Waste Processing and Storage	14	5	1.6	1.8	0.5	Loss	2.5	13	1.1	8.0	0.5	Loss	2.5	13	1.1	8.0
V. Fuel Cycle	7	2	Loss	Loss	Loss	Loss	9.5	83	1.1	8.0	Loss	Loss	9.5	83	1.1	8.0

(a) Includes offices of private physicians at a size standard of $1M annual sales. Weighted average sales for the category is $3,265,250.

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blanket coverage, financial assurance costs would significantly reduce the rate of return on assets if the cost were fully absorbed by the licensees. The smallest percentage reduction in return would be for those licensees in manufacturing and distribution. With the sliding scale coverage shown in Table 1.2, the impact on several of the classes of licensees would be smaller. If licensees were to attempt to compensate for cost increases with blanket $2M coverage, sales volume would have to increase between 1.7% and 9.5% to maintain net income, or price would have to increase by 1.1%. As can be seen from the table, the required increases for many categories of licensees are less onerous with sliding scale coverage.

Because our analysis of the DRR Survey results indicated that many licensees covered by the ANPRM have much less than $3.5M in annual billings, Table 5.8 also shows the impact of financial assurance on the subset of firms with $500,000 annual sales.(a) These results might be more typical for the group of firms having annual sales less than $1M, which is a significant majority of all firms in the DRR Survey qualifying as small businesses. At the $500,000 level of sales, the impacts of the proposed rulemaking are far more significant. The annual cost of blanket coverage of $2M, for example, could place many licensees in the $500,000 size range into a loss position if they were to attempt to absorb the cost of financial assurance. However, neither sales volume increases nor price increases appear to be attractive options for maintaining income: it would be difficult to expand sales volume by the required 11-83% shown in the table if all licensees were simultaneously trying to do so. At the same time, price competition from larger firms probably would make the 8% price increases necessary to maintain net income of small firms difficult to accomplish. (Note also that the average firm of this size lost money on average in the 1982-1983 period even without the proposed rule.)(b) Sliding scale coverage gives some relief. The impact would be still quite severe, though, on small firms licensed for relatively large amounts of radioactive material.

5.4 QUALIFYING NOTE ON THE QUANTITATIVE RESULTS FOR CONVENTIONAL FINANCIAL MECHANISMS

A key assumption underlying the quantitative analysis in Sections 5.1-5.3 is that each licensee is a separate business and is charged the same amount for a given amount of insurance or other financial assurance. Thus, small licensees are assumed to be charged the same amount per $1,000 coverage as their larger competitors, who may possess more separate potential sources for radioactive materials spills (e.g., more gauges, well-logging devices, etc.). The cost of financial assurance per licensee logically would increase (not necessarily linearly), as the number of radioactive sources (especially unsealed

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(a) Statistics for firms with sales less than $500,000 are also included in the column for firms with sales less than $3.5M. For example, there are approximately 2,536 Category I small businesses of which 1,047 have annual sales less than $500,000 (Table 5.8).

(b) IRS 1985.

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sources), licensed curie quantity, number of previous accidents, half-life of the source material, and potential complexity of offsite cleanup increase (see Appendix A). To some extent these relative risk factors are taken into account by the categories of firms designated for sliding scale coverage in Table 1.2. However, the number of sources is not. If we had made the alternative assumption that the cost of coverage would be proportional to the number of sources instead of constant, a licensee with 10 sources might be charged $300 per $1,000 coverage instead of $30. This assumption would have increased the total cost of financial assurance to industry shown in Table 5.2, but small firms would be more likely to be able to increase price in competition with their larger competitors. However, insurance industry practice for other forms of insurance suggests that charges per $1,000 coverage would not increase linearly with the number of sources. There are no data available that would permit us to better match sales volume to number of radioactive sources,[a] but there is little reason to believe that that relationship is linear, either. Given the lack of data, we believe that the constant cost assumption is closer to the truth than the alternative assumption of linearity, but the issue bears further examination because of its consequences for total cost and distributional impact.

It should also be noted that the annual sales size categories for NRC licensees used in the analysis in Section 5 are based on total annual sales from all business activities, not just activities related to use of radioactive materials. Sales information was obtained from the 1983 DRR Survey of materials licensees, and is different from the annual sales information presented in Section 2. Section 2 sales data include only sales from radionuclide activities. Thus, the analyses in the two sections are not comparable. Data were not available to allocate licensees to sales volume classes based on radionuclide-related sales alone. Use of all sales data in Sections 5.1-5.3 understates the impact on the "nuclear business" of financial assurance regulation, since costs for financial assurance would likely be charged by multiproduct firms against the nuclear portion of their businesses only in deciding whether to continue to offer goods and services in which nuclear materials are used.

Tables 5.4 through 5.8 present the cost of the proposed financial assurance rule to an average licensee assuming various levels of annual sales. However, the impact of this rule would vary according to the type of business being conducted. Table 5.9 provides information on financial cost (based on $20/$1,000 of coverage) as a percentage of net income for specific businesses included in the major categories of licensees. The impact is calculated for the low ($0.1M) and high ($2M) extremes of the proposed rule. The largest relative impact (about 400% of net income) would be on businesses in research and development, general manufacturing and nuclear pharmacies having sales of $1M or less and required to have $2M coverage. The impacts generally decrease as annual sales increase; however, these costs still represent over 8% of net income for glass manufacturers with annual sales greater than $25M. The impact

(a) NRC materials licenses do not indicate exact quantities of radioactive material or number of separate sources.

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TABLE 5.9. Variation in the Impact of the Proposed Financial Assurance Rule on Net After-Tax Income of Licensees, by NRC Category, Type of Business, and Annual Sales

Category of Licensee and Type of Business	Cost as a Percentage of Net Income					
	$1M Sales		$7M Sales		$25 Sales	
	Coverage $0.1M	Coverage $2.0M	Coverage $0.1M	Coverage $2.0M	Coverage $0.1M	Coverage $2.0M
I. Research, Teaching, Diagnostic, Therapeutic						
a. Educational Services	12	251	4.4	88	0.1	1.5
b. Medical Institutions	Loss	Loss	Loss	Loss	Loss	Loss
c. Nuclear Laundries	10	209	1.4	27	3.5	7.0
d. Medical Practice	3.6	72	Loss	Loss	0.6	13
e. Research and Development	20	400	1.2	23	0.3	5.3
f. Medical Laboratories	4.4	87.4	0.4	7.0	Loss	Loss
II. Measurement, Calibration, Irradiation						
a. Manufacturing (General)	20	400	1.2	23	0.3	5.3
b. Radiographers, Leak Test, Calibration Services	10	209	1.4	27	0.3	7.0
c. Well Logging	11	214	0.9	18	0.1	2.6
III. Manufacturing and Distribution						
a. Scientific Instrument Manufacture	Loss	Loss	1.2	24	0.1	2.2
b. Drug Manufacture	3.5	70	7.5	150	0.1	1.2
c. Nuclear Pharmacies	18	351	1.4	28	0.3	5.5
d. Glass Manufacture (Source Material)	6.3	126	0.3	6.9	0.4	8.2
IV. Waste Processing and Storage		209		27		7.0
V. Fuel Cycle						
a. Mines and Mills		Loss		Loss		3.6
b. Electric Utilities		Loss		20		5.2

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of financial assurance is considerably reduced for firms required to have only the minimum coverage ($0.1M). Here, the impacts range from about 20% of net income down to about 0.1%.

5.5 COST OF CAPTIVE INSURERS

Captive insurance companies have a number of potential advantages as an alternative to commercial property/casualty insurers for providing financial assurance (Section 4.2.1). Together, these advantages are likely to enable captive insurers to charge their insureds lower premiums than commercial insurers.

Table 5.10 presents a comparison of the annual cost of coverage for captive versus conventional mechanisms for the Table 1.2 sliding scale coverage. Estimates are provided for both annual costs per licensee and for total annual costs per licensee category. The costs for the conventional financial assurance mechanisms are from Table 5.2.

The risk-based annual cost per licensee for insurance coverage from a captive insurer is for the most part dramatically less than it would be from conventional sources for most categories of licensees. For licensees involved in research, teaching, diagnostics or therapeutics having less than 0.1 curie, for example, the annual after-tax cost would be reduced from $1,320 to $6. The total annual cost for all licensees within this category would be reduced from $4.6M to $22,200. The annual costs to all materials licensees for captive insurance would be about $4M after-tax compared with about $100M for coverage from a conventional source.

The annual cost of insurance to licensees in the Waste Processing and Storage and Fuel Cycle categories shown in Table 5.10 is somewhat greater than the cost for conventional mechanisms. The reason for this cost cross-over is the way costs from a captive insurer are assumed to be allocated to the various categories of licensees. In Table 5.10, the claims, administration, and inspection costs for any one category of materials licensee (reported in more detail in Table 5.11) are based on an index of relative risk, where relative risk is defined as the probability of an accident multiplied by cleanup cost, compared with the probability of accident times cost for the average licensee. Since the probability-weighted cleanup cost at a Waste Processing and Storage or Fuel Cycle site could be much greater than the cleanup costs at other material licensee sites, these categories of licensees are assumed to be responsible for carrying a greater portion of the captive insurance company's costs of operations.

The annual premium cost to each licensee in Table 5.10 includes funds needed for claims, for administrative costs, and for onsite inspections of an insured's licensed radioactive materials and associated facilities. A breakdown of each of these cost elements is shown in Table 5.11. No cost is included in Table 5.11 to represent the opportunity costs associated with capital funds invested in the captive.

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TABLE 5.10. Comparison of After-Tax Annual Cost for Captive Insurer Versus Conventional Mechanisms for Sliding Scale Coverage

Category of Licensee	Number of Licensees	Annual Premium Cost/Licensee		Total Annual Cost	
		Captive	Conventional	Captive	Conventional
I. Research, Teaching, Diagnostic, Therapeutic					
a. Less than 0.1 Curie	3,498	$ 6	$ 1,320	$ 22,200	$ 4,600,000
b. 0.1 to 1 Curie	1,116	46	3,300	51,400	3,700,000
c. 1 to 10 Curies	1,772	79	6,600	140,600	11,700,000
d. 10 to 100 Curies	372	190	13,200	70,800	4,900,000
e. More than 100 Curies	531	317	26,400	168,500	14,000,000
II. Measurement, Calibration, Irradiation					
a. Less than 0.1 Curie	4,151	$ 5	$ 1,320	$ 19,800	$ 5,500,000
b. 0.1 to 1 Curie	1,486	32	3,300	47,200	4,900,000
c. 1 to 10 Curies	1,089	63	6,600	69,100	7,200,000
d. 10 to 100 Curies	346	143	13,200	49,400	4,600,000
e. More than 100 Curies	1,181	254	26,400	299,800	31,200,000
III. Manufacturing and Distribution					
a. Less than 0.1 Curie	228	$ 63	$ 1,320	$ 14,500	$ 300,000
b. 0.1 to 1 Curie	162	365	3,300	59,100	500,000
c. 1 to 10 Curies	129	825	6,600	106,400	900,000
d. 10 to 100 Curies	161	2,063	13,200	332,100	2,100,000
e. More than 100 Curies	66	3,650	26,400	240,900	1,700,000
IV. Waste Processing and Storage	33	$31,736	$26,400	$1,047,300	$ 900,000
V. Fuel Cycle	28	$44,431	$26,400	$1,244,100	$ 700,000
Total	16,349			$3,983,200	$99,400,000

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TABLE 5.11. Estimated Annual Premium Payments by Licensees to Hypothetical Captive Insurer

Category of Licensee	Portion of Premium for			Total Premiums	
	Claims	Administration	Inspection	Before Tax	After Tax
I. Research, Teaching, Diagnostics, Therapeutic					
a. Less than 0.1 Curie	$ 17,980	$ 4,495	$ 11,140	$ 33,615	$ 22,186
b. 0.1 to 1 Curie	41,616	10,404	25,784	77,804	51,351
c. 1 to 10 Curies	113,940	28,485	70,593	213,018	140,592
d. 10 to 100 Curies	57,407	14,352	35,567	107,326	70,835
e. More than 100 Curies	136,573	34,143	84,615	255,331	168,518
	$367,516	$91,879	$227,699	$687,094	$453,482
II. Measurements, Calibration, Irradiation					
a. Less than 0.1 Curie	$ 16,023	$ 4,006	$ 9,927	$ 29,956	$ 19,771
b. 0.1 to 1 Curie	38,220	9,555	23,680	71,455	47,160
c. 1 to 10 Curies	56,018	14,005	34,707	104,730	69,122
d. 10 to 100 Curies	40,046	10,011	24,811	74,868	49,413
e. More than 100 Curies	243,003	60,751	150,555	454,309	299,844
	$393,310	$98,328	$243,680	$735,318	$485,310
III. Manufacturing and Distribution					
a. Less than 0.1 Curie	$ 11,728	$ 2,932	$ 7,266	$ 21,926	$ 14,471
b. 0.1 to 1 Curie	47,916	11,979	29,687	89,582	59,124
c. 1 to 10 Curies	86,265	21,566	53,446	161,277	106,443
d. 10 to 100 Curies	269,160	67,290	166,761	503,211	332,119
e. More than 100 Curies	195,215	48,804	120,947	364,966	240,878
	$610,284	$152,571	$378,107	$1,140,962	$753,035
IV. Waste Processing and Storage	$848,760	$212,190	$525,858	$1,586,808	$1,047,293
V. Fuel Cycle	$1,008,224	$252,056	$624,656	$1,884,936	$1,244,058
	$3,228,094	$807,024	$2,000,000	$6,035,918	$3,983,178

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The portion of the premium needed for claims is based on risk assessment work conducted for NRC by SNL.[a] SNL examined past accident frequency and associated cleanup costs for the various licensee categories. Their estimate of the expected cleanup costs/license/yr for licensee categories I, II, and III, is shown in Table 5.1 of Ostmeyer. The costs were converted to a per licensee basis for this report assuming 1.286 licenses per licensee.[b] SNL found no accidental releases for category IV licensees for the period mid-1980 through mid-1986. For the purposes of developing costs for this category, we assumed that the number of incidents in a year is distributed as a Poisson random variable over the six-year period. This assumption suggests that a reasonable accident frequency for category IV licensees consistent with 0 observed incidents during the six-year period with a 95% upper confidence bound is 0.01 incidents/licensee/yr. For category V licensees, SNL found an incident frequency of 0.014 incidents/license/yr.[c] With these incident frequencies, and an assumed $2M cleanup cost (the maximum coverage from Table 1.2), the 1.286 factor, and the premium cost for claims in Table 5.11 was estimated for category IV and V licensees.

Administrative costs in Table 5.11 are assumed to be 25% of premiums needed for claims (Section 4.2.4.3). Inspection costs are assumed to be $2M/yr. Both administrative and inspection costs are distributed by licensee category in proportion to premium revenue needed for claims. After-tax costs were calculated assuming a corporate tax rate of 34%. Income realized by the captive from investing premium revenue is not reflected in Tables 5.11 and 5.12 nor are taxes paid by licensees on the investment income.

5.6 ADMINISTRATIVE COSTS

Adoption of a financial assurance rule will likely require the NRC and the Agreement States to verify annually that each materials licensee has the appropriate financial coverage. This verification will require staff time to review the documentation provided by the licensee.

Several Agreement States that require financial assurance were contacted to estimate the administrative costs associated with this type of regulation. Little information on administrative costs was available from the states, however, due to the small number of licensees involved. Tennessee, for example, currently requires only about 1% of their materials licensees to have surety

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(a) Robert M. Ostmeyer, SNL, and Dawn J. Skinner, GRAM, Inc., Albuquerque, New Mexico, A Preliminary Evaluation of the Economic Risk for Cleanup of Nuclear Material Licensee Contamination Incidents, NUREG/CR-4825, SAND86-2108, March 1987. Hereafter cited as "Ostmeyer."

(b) The DRR data set contained 9,000 licenses and 7,000 licensees (see Appendix C).

(c) Ostmeyer, Table 3.1.

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TABLE 5.12. Annual Administrative Costs of a Financial Assurance Rule to NRC and Agreement States

Category of Licensee	Number of Licensees	Costs of Administering Insurance, Surety Bonds, Letters of Credit, and Escrow Account Mechanisms[a]	Costs of Administering the Financial Test Mechanism[b]
I. Research, Teaching, Diagnostic, Therapeutic			
a. Less than 0.1 Curie	3,498	$1,539,000	$3,078,000
b. 0.1 to 1 Curie	1,116	491,000	982,000
c. 1 to 10 Curies	1,772	780,000	1,559,000
d. 10 to 100 Curies	372	164,000	327,000
e. More than 100 Curies	531	234,000	467,000
II. Measurement, Calibration,			
a. Less than 0.1 Curie	4,151	$1,826,000	$3,653,000
b. 0.1 to 1 Curie	1,486	654,000	1,308,000
c. 1 to 10 Curies	1,089	479,000	958,000
d. 10 to 100 Curies	346	152,000	304,000
e. More than 100 Curies	1,181	520,000	1,039,000
III. Manufacturing and Distribution			
a. Less than 0.1 Curie	228	$100,000	$201,000
b. 0.1 to 1 Curie	162	71,000	143,000
c. 1 to 10 Curies	129	57,000	114,000
d. 10 to 100 Curies	161	71,000	142,400
e. More than 100 Curies	66	29,000	58,000
IV. Waste Processing and Storage	33	15,000	29,000
V. Fuel Cycle	28	12,000	25,000
Total	16,349	$7,194,000	$14,387,000

(a) Based on a cost of $440/licensee/year.
(b) Based on a cost of $880/licensee/year.

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bonds to cover the cleanup of accidental releases.[a] Administration of the Tennessee rule involves a brief annual review of the surety bond documentation. The total cost to the state of administering this rule is unknown, but believed to be minimal due to the limited number of licensees involved.

The costs of administering a financial assurance rule would be likely to depend on the financial mechanism adopted. Insurance, surety bonds, standby letters of credit, and escrow accounts would require a brief annual review to ensure authenticity and adequacy of coverage. It is assumed that this review would require about 8 man-hours per year per licensee.[b] The annual cost (including overheads) of a mid-level federal employee is about $100,000.[c] The costs of mid-level state employees are expected to be similar to the federal costs. Thus the cost of administering the financial assurance rule if licensees were required to have insurance, a surety bond, a standby letter of credit, or an escrow account, would be about $435/licensee/yr. If we assume that all 16,349 affected materials licensees would be required to have this coverage, the administrative costs would be approximately $7.1M/yr. It is possible that this total could be lower if standard policy language were adopted by NRC and/or if all licensees were insured by a single captive insurer.

The costs of the financial test/corporate guarantee to the licensees would be relatively low since no annual fees would have to be paid and since similar documentation would already presumably be prepared for tax accounting and/or reporting purposes. However, since this mechanism would probably require relatively more documentation than verification of an insurance policy, the cost to the NRC or Agreement States would be greater in terms of staff time. It is also likely that both the NRC and Agreement State staff will (over time) become more efficient in reviewing these documents. Therefore, it is assumed that in the early stages of the program, two man-days would be required to review each financial statement, representing a cost of about $870/licensee/yr. This level of effort would represent a total cost for administration for 16,349 licenses of approximately $14.2M/yr. However, the time required to review these statements would likely be reduced to about 1 man-day at a cost of $435/licensee/yr within a few years of the rule's implementation. This could eventually reduce the administrative costs to approximately $7.2M/yr, the same cost as the other mechanisms. Much of the cost to NRC and Agreement States of administering a financial assurance rule could potentially be recovered through license fees. NRC has a schedule of fees for materials licensees at 10 CFR 170.31.

(a) Personal communication with Charles West, Tennessee Department of Health and Environment, Nashville, TN, March 27, 1986.

(b) The state of Wyoming, for example, spends roughly 8 hr/yr administering its land reclamation financial assurance rule for surface mine operators. Personal communication with Vicki J. Bryan, Wyoming Department of Environmental Quality, Cheyenne, Wyoming, April 1, 1986. The 8 hr/licensee estimate includes staff, secretarial/clerk, and management time.

(c) Heaberlin, S. W., et al., A Handbook for Value Impact Assessment, NUREG/CR-3568, December 1983.

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6.0 BENEFITS AND COSTS OF A FINANCIAL ASSURANCE RULEMAKING

This section summarizes the benefits and costs that can be anticipated if financial assurance requirements as outlined in the ANPRM are implemented. The benefits and costs are summarized in Table 6.1 and discussed in Sections 6.1 and 6.2.

6.1 BENEFITS

If a rule based on the ANPRM is implemented, several benefits are likely to be realized. The most important benefit is the assurance that all cleanup

TABLE 6.1. Approximate Recurring Annual Social Benefits, Costs and Equity Effects of a Financial Assurance Rule

	Benefits		Costs	
Quantifiable				
	Reduced administrative time to secure funding	$100-600K	Opportunity cost to licensees of capital	$1M
			Administrative costs to insurer	$0.8M
			Inspection costs	$2M
			Administrative costs to government	$7M
Equity Effect				
	Reduced taxpayer funded cleanup cost	$1-5M		
Nonquantifiable				
	More rapid cleanup resulting in meeting public concerns sooner and possibly reducing occupational and public exposure			
	Possible reduction in accidental releases			

Assumptions: 1. Costs are for a captive insurer.
2. All figures are before taxes.

costs would be paid by licensees or third parties compensated by licensees to provide cleanup assurance. The financial burden of paying for cleanup of accidental radionuclide releases would thus be incurred by licensees and their customers rather than general taxpayers. The savings to taxpayers would vary from year to year. The highest amount paid between 1979 and 1986 was approximately $3.5M paid in 1983.

A second benefit is a reduction in the time legislatures and regulatory agencies would be required to spend finding cleanup funds when a licensee causing a release of radioactive material is insolvent or unwilling to pay for cleanup. The New York state legislature, for example, appropriated special funds to pay for cleanup of the EAD Metallurgical, Inc. site (Table B.1). It is very difficult to estimate exact savings to regulatory agencies, but it appears that at least one man-year (i.e., roughly $100K) has been spent in prior incidents where cleanup funding was not available from the licensee.(a)

A third possible benefit is that a financial assurance mechanism could potentially lead to more rapid cleanup of released radioactive materials. More rapid cleanup could have two benefits. First, public concerns about the accident and the cleanup process could be satisfied sooner. Second, more rapid cleanup could potentially result in reduced occupational and public health effects. The reduced health effects are difficult to quantify, but are likely to be relatively small. Accidents with the potential to cause adverse health effects are likely to be cleaned up regardless of whether a NRC financial assurance rule is implemented. Cleanup funds could come from the licensee or his insurance carrier, the EPA-administered Superfund or state-administered mini-Superfunds, state or federal emergency response funds, or other sources. In a few cases, e.g., Sweeney Mining and Milling (Table B.3), cleanup activities have been delayed because of funding constraints. It is expected, however, that cleanup at sites where the licensee is insolvent would be delayed only when health risks are minimal.

A fourth possible benefit is that the number of incidents involving releases of radioactive materials may decrease. Again, the potential benefits are difficult to quantify. Conceptually, however, a financial assurance requirement may mean that a high-risk licensee with inadequate capitalization, poor safety practices and/or a poor safety history would be unable to obtain the needed assurance and consequently would be either ineligible for a new or renewed license or would be forced to surrender an existing license. Additionally, if premiums are based on past accident history, a licensee would have an economic incentive to minimize future accidental releases.

(a) NRC staff members for example, invested the following approximate hours in these incidents from Table B.1: J. C. Haynes (5,000), Shellwell Services (1,600 hours), and International Neutronics (1,500 hours). Personal communication with Mary Jo Seemann, NMSS, February 19, 1987.

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6.2 COSTS

The least expensive mechanism to provide the financial assurance discussed in the ANPRM is likely to be one or more captive insurers. From society's standpoint, the costs associated with providing financial assurance through a captive include the opportunity cost of capital contributions to the captive, the administrative cost of operating the captive, and the cost of site inspections performed by the captive. An additional cost is the nonrecurring cost of forming a captive. The portion of the premiums allocated for cleanup should roughly offset cleanup costs and are hence not considered here as a societal cost.

Using the reasoning of Section 5.1.2.5, the opportunity cost of a $20M capital investment for a captive (Section 4.2.4.2) would be approximately $1M/yr. The annual administrative cost of operating the captive would run roughly $0.8M/yr (Table 5.11). The annual cost of inspections is assumed for this report to run about $2M/yr (Section 4.2.4.3). Inspection costs could fluctuate widely over time depending on how useful the inspections are perceived to be. Site inspections may lead to reduced accidents over time as discussed above.

Another category of costs is costs to government. The annual cost to NRC and Agreement States of administering a financial assurance rule is likely to be on the order of $7M/yr (Section 5.5.6). Some or all of this cost could potentially be recovered through license fees imposed by regulatory agencies. Additional nonrecurring costs are the cost to NRC of developing and promulgating a financial assurance rule and the cost to amend existing materials licenses with the financial assurance requirement. It is also possible that some existing licensees would want to amend their license to a smaller licensed quantity of material to qualify for a lower financial assurance requirement (see Table 1.2).

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APPENDIX A

INSURANCE INDUSTRY VIEWS ON AVAILABILITY OF CLEANUP COVERAGE

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APPENDIX A

INSURANCE INDUSTRY VIEWS ON AVAILABILITY OF CLEANUP COVERAGE

Telephone calls were made in early October, 1986, to various insurance companies and associations to determine whether an insurance market exists for cleanup and environmental restoration of relatively low-level radiation releases. Two other purposes of the calls were to obtain cost information on premiums and deductibles if CGL or EIL policies were offered for pollution exposure risk, and to obtain the opinions of insurance industry representatives on a key assumption used in this report, namely that cleanup and environmental restoration insurance would cost $30 per $1000 of coverage. A list of persons contacted is shown in Table A.1.

A.1 AVAILABILITY OF COVERAGE

The information obtained from the telephone contacts was consistent, and each of the sources tended to corroborate what the others had said. The consensus view was that insurance for cleanup and environmental restoration as a

TABLE A.1. Insurance Industry Contacts

Name of Company/Association	Person Contacted	Telephone	Contact Date
American Home Assurance	Todd Cunningham	(212)770-7000	10/15/86
American Nuclear Insurers	Charles Bardes	(203)677-7305	10/15/86
Continental Insurance	Mariel Carnavale	(212)440-7294	10/16/86
Environmental Compensation Services	Betty Ash	(215)269-6731	10/15/86
Independent Insurance Agents of America	James Zarnowski, Research Manager	(212)285-4250	10/14/86
Peel and Holland	R. C. Riley	(502)527-8621	10/13/86
Pollution Liability Insurance Association	Tom Knowlton, President	(312)969-5300	10/16/86
Pollution Liability Insurance Association	James Moro, Chairman of the Board	(312)969-5300	10/16/86
The Travellers	Doug Clark	(203)277-0111	10/13/86

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result of a release of radioactive materials was not currently being offered. The only apparent exceptions to this view were insurance for some hospital activities, university research laboratories, and (perhaps) spent fuel storage facilities.

The following examples provide an indication of the responses received. James Moro, the Chairman of the Board of PLIA, said that no market currently exists for radionuclide cleanup coverage with the exception of hospitals, and that if such a market did exist, PLIA and its member companies would be involved in providing coverages.[(a)] Tom Knowlton, the President of PLIA, stated that to his knowledge the PLIA pool had not written any policies related to release of radioactive materials, again excepting hospitals. R. C. Riley, chairman of the Independent Insurance Agents of America (IIAA) pollution liability task force, said that with the exception of AIG and PLIA, the insurance market was not accepting pollution exposure risk of any kind. He went on to say that a rule such as the one being considered by the NRC would present problems because the insurance industry would not be able to provide the required coverage. James Zarnowski, research manager of IIAA, said his general impression was that no one was offering EIL insurance for radioactive materials. He indicated that this was due in part to the lack of information surrounding the nuclear field, which makes estimating the possible losses from an accident difficult to calculate and thus difficult to price.

Several AIG members and several unassociated insurance companies were also contacted to see if they offered policies for potential radiation exposure. Todd Cunningham of American Home Assurance, an AIG member, indicated that pollution exposure policies are offered by American Home, but that radioactive materials are excluded from coverage. Mariel Carnavale, Continental Insurance, said Continental writes EIL policies, including some that cover low-level radionuclide activity such as hospital use of dyes and universities with research laboratories. He stressed, however, that when these activities are covered they are incidental to the overall coverage. He noted in addition that cleanup is not covered in and of itself, and that it would only be covered if linked to property damage or personal injury offsite. He also indicated that Continental would only insure site-specific operations where engineering assessments had first been conducted; operations such as well logging that were not site-specific would not be covered.

Mr. Carnavale's information was closely echoed by Doug Clark of The Travelers. Like Continental, The Travelers offers EIL insurance to several low-level operations involving radioactive materials licensees such as hospitals and universities, but not to waste disposal sites. Such coverage is contingent on a positive finding from an engineering study of the site and applies predominately to third parties, although some insureds are granted cleanup coverage. According to Mr. Clark, The Travelers does not offer CGL coverage that includes pollution exposure.

(a) Policies are issued by member companies and reinsured by PLIA.

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Only one contact, Charles Bardes of American Nuclear Insurers (ANI), said that coverage for a licensee other than a hospital or university might be available. Although ANI has never covered hospitals, he indicated it might cover independent spent fuel storage facilities, one class of licensee considered in the ANPRM. ANI coverage applies to offsite activities that are "sudden and accidental," thus damages caused onsite through the gradual buildup of released radioactive materials are not covered.

A.2 COST OF NUCLEAR CLEANUP AND HAZARDOUS WASTE COVERAGE

The sources contacted indicated that, except for a few industries, the conventional insurance market currently does not offer insurance related to release of radiative materials. The lack of a relevant market frustrated the second objective of the telephone interviews--to determine the cost of such insurance. In response, two approaches were taken. One approach was to ask each source how much radiation release cleanup insurance might cost at a minimum if a market for it existed; the other was to ask how much insurance would cost at a minimum for non-nuclear hazardous material. To both questions the common response was that it was impossible to say due to the large number of variables involved, such as the nature of the industry, the location of the site, the competence of the management, site hydrology and so forth. For example, Tom Knowlton, the President of PLIA, said there are probably 100 or so factors that go into the setting of premiums at PLIA, which explained his reluctance to provide any specific cost information. Fortunately, some rough estimates were obtained, and are discussed below.

R. C. Riley said that if EIL insurance were offered for a "generic hazardous waste," the minimum premium would probably be $25,000 ($15,000 at the lowest) for $1M of coverage for each occurrence, $2M in aggregate. Betty Ash, Environmental Compensation Services, Inc., indicated that under an EIL policy for PCBs or hazardous waste transporters, the minimum premium would be $30,000 for $10M of coverage. It was not clear whether the $10M is per occurrence or is the aggregate amount. She also said such coverage would only be offered after an engineering analysis of the operation were completed, and that the analysis would likely cost $7,000-$12,000, paid by the potential insured regardless of whether insurance were subsequently offered.

Todd Cunningham indicated that a minimum EIL policy, (e.g., for a municipal waste transfer station) would cost $10,000 per $1M of coverage per occurrence, with $1M of losses allowed in a policy year. The deductible would be $25,000. This policy would apply to third parties offsite. A CGL policy for the same scenario would cost $20,000 per $1M (per occurrence), with a $100,000 deductible. Coverage would be available to $10M.

Finally, as a potential upper bound for exposure coverage, Charles Bardes of ANI said premiums for a nuclear reactor run $40,000-60,000 per million dollars of coverage, with no deductibles. $160M is offered over the life of the policy, which is a claims-made policy. The policy is provided for offsite accidents that are "sudden and accidental."

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A.3 COST ASSUMPTION USED IN THIS REPORT

The third purpose of the telephone interviews was to obtain insurance industry opinions on the reasonableness of the insurance cost assumption used in this report. Individuals contacted during the phone calls were asked to comment on our assumption of insurance costing $30 per $1,000 of coverage, and were asked to supply an alternate figure if appropriate. The individuals were asked to comment on this assumption assuming a market for cleanup of releases of radioactive materials by licensees existed.

The most frequent response was that it was impossible to comment on the assumption at all, either due to the number of variables involved or due to reluctance to supply hypothetical numbers. Those individuals (e.g., Doug Clark, Todd Cunningham, and R. C. Riley) who were willing to comment usually said that the assumption was at least within a reasonable error bound. For example, Doug Clark, the Travelers, said the assumption is "possible," while Todd Cunningham, American Home Assurance, said the assumption "sounds reasonable." R. C. Riley, chairman of the Independent Insurance Agents of America pollution liability task force, said there is a "50/50 chance" that the assumption is correct. Tom Knowlton initially indicated that the assumption sounded reasonable, but when the range of potential licensees was reemphasized, e.g., from radiation therapy to independent fuel storage facilities, he indicated that the cost of coverage depends on the particular industry. Mariel Carnavale, Continental Insurance, also indicated that the cost of insurance would depend on the industry, but said that the differences might still yield an average cost comparable to the $30/$1000 assumption. Finally, Charles Bardes, ANI, said that for an independent spent fuel storage facility, the cost assumption might be high by $15-20 per $1000 of coverage for the kind of coverage ANI provides, which includes property damage and personal injury.

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APPENDIX B

SUMMARY OF PAST NUCLEAR MATERIALS LICENSEE ACCIDENTS AND CLEANUP EFFORTS

APPENDIX B

SUMMARY OF PAST NUCLEAR MATERIALS LICENSEE ACCIDENTS AND CLEANUP EFFORTS

This appendix has two sections. The first section provides a list and description, in Tables B.1 through B.4, of nuclear material licensee accidents and cleanup efforts known to the authors. The second section examines the available information on cleanup costs for these incidents. The cost information is summarized in Tables B.5 and B.6. The tables are for the most part limited to the types of licensees potentially included in the NRC rulemaking. For example, incidents involving facilities owned by the federal government and regulated trucking firms are excluded. The information sources used in generating the table entries are shown in Table B.7.

Tables B.1 through B.4 contain the name of the company or entity involved in the accident, the type of radionuclide released, the amount of the release (in curies), the estimated cleanup cost (in nominal, i.e., unadjusted, dollars), the dates of the accident and cleanup, whether cleanup activities have been completed, the location, and a description of the incident and relevant notes. Each table is organized chronologically by the year of the cleanup (and, where unavailable, by the year of the incident), with the most recent cleanup activities listed first.

Table B.1 lists the incidents for which the cost of the cleanup was paid directly by a state or federal agency or through a trust administered by a public agency. Of the 58 total incidents listed in this appendix, nine fall into this category. Table B.2 lists the accidents for which the licensee or its insurance carrier paid the cost of the cleanup, a total of 36 entries. (This table also includes several cases involving nonlicensees.) Table B.3 contains a single case where cleanup was completed but it is unclear who the payer was. Table B.4 lists 12 incidents where no cleanup action has apparently occurred and it is therefore unknown whether the companies involved, the states, or perhaps the EPA- or a state-administered Superfund will pay for the cleanup activities.

Tables B.5 and B.6 summarize the information from Tables B.1 and B.2 on cleanup costs. It is important to note that the cost estimates in Tables B.1 and B.2 are for both completed and ongoing cleanup efforts, and that no distinction between the two is made in Tables B.5 and B.6. Table B.5 provides aggregate cleanup cost estimates by year in 1985 constant dollars and the number of incidents per year for the years 1979 through 1986. Incidents are divided into those for which the licensee or its insurance carrier paid for cleanup, and those for which Superfund or the states paid. The 1979-1986 time span was used because it includes nearly all of the verifiable cleanup cost estimates from Tables B.1 and B.2. Table B.6 presents a percentage breakdown of the 1979-1986 cumulative cleanup costs by payer. For example, it shows that 11% of the aggregate cleanup costs incurred between 1976 and 1986 were paid out of the EPA-administered Superfund.

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TABLE B.1. Incidents Where Cleanup Costs Were Paid by State or Federal Government

Case	Radionuclide and Activity Released (Ci)	Estimated Cleanup Cost and Payer	Dates	Location	Notes
EAD Metallurgical, Inc.	Am-241 4 Ci	$1,400,000[a] (New York State)	Accident: 1983 Cleanup: 1984-1986 Completed: Yes	Townawanda, New York	Decontamination of plant, local sewer, sewage treatment plant, landfill. State Attorney General attempting to get EAD's insurance co. to pay decontamination costs.
American Radiochemical	C-14 5 Ci	$120,000[a] (Superfund)	Accident: 1980-1981 Cleanup: 1985 Completed: Yes	Sanford, Florida	Nature of accident not specified. American Radiochemical filed for bankruptcy. The lessor, Sanford Airport Authority, now the licensee, lacked financial means to clean up.
John C. Haynes	Am-241 12 Ci	$385,000[a] (Superfund)	Accident: 1970s Discovery: 1983 Cleanup: 1985 Completed: Yes	Newark, Ohio	Contamination of laboratory in residence in rural area from unauthorized use of material.
Luminous Processes	Ra	$3,500,000 (Illinois)	Accident: 1940s, 1950s Cleanup: 1985 Completed: No	Ohawa, Illinois	Decommissioning of watch dial plant. Contaminated brick building and equipment. Cost listed is for decommissioning. Plant closed in 1978.
Maxey Flats Low-Level Waste Site	Tritium Co-60 Sr-90	$130,000 has been spent, may cost $30,000,000. (Superfund)	Site accepted wastes: 1962-1977. Cleanup: Ongoing Completed: No	Kentucky	Off-site releases above background.
Private Residence	Ra	$700,000 (Superfund)	Accident: 1940s Cleanup: 1983 Completed: Unknown	Cleveland, Ohio	Radium from watch dial business stored in backyard of private residence. Cost listed is for decontamination of residence and watch dial building.
Grace Properties	U Ra Th	$30,000,00 - $90,000,000 (DOE)	Accident: Late 1960s through early 1970s Cleanup: 1980s Completed: No	Wayne, New Jersey	Contamination of facility from rare earth or other ore processing operations. Large volume, low activity waste. DOE cleanup under special appropriation from Congress.

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TABLE B.1. (contd)

Case	Radionuclide and Activity Released (Ci)	Estimated Cleanup Cost and Payer	Dates	Location	Notes
Luminous Processes, Inc.	Ra-226 482.7 Ci	$678,955[a] (90% Superfund, 10% Georgia)	Accident: 1952-1978 Cleanup: 1982 Completed: Yes	Georgia	Soil and inside of building contaminated due to improper disposal of radium paint and clock dial.
American Atomics Company	Tritium 4000 Ci	$650,000[a] (Arizona)	Accident: 1979 Cleanup: 1979 Completed: Yes	Tucson, Arizona	Tritium contamination on and offsite, including food contamination. Licensee financially unable to pay.

(a) These cost estimates are taken from Table c.1 of Ostmeyer.

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TABLE B.2. Incidents Where Licensee/Insurance Carrier Paid Cleanup Costs

Case	Radionuclide and Activity Released (Ci)	Estimated Cleanup Cost	Dates	Location	Notes
Sequoyah Fuels Corp.	UF_6	Less than $2,000,000	Accident: 1986 Cleanup: 1986 Completed: Yes	Gore, Oklahoma	Ruptured UF_6 cylinder at nuclear fuels processing plant.
C-E Glass, Inc.	Co-60 0.900 Ci	$2,500	Accident: 1986 Cleanup: 1986 Completed: Yes	Missouri	Site abandoned. Disposal of nuclear gauges.
Sun Flame Appliance	Th	$500,000-$600,000	Cleanup: 1986 Completed: No	Illinois	No details on accident. Case is ongoing. Badly contaminated building.
International Nutronics	Co-60	Several $million	Accident: Late 1970s and 1980s Cleanup: 1986 Completed: Yes	New Jersey	Pool irradiator, on and off-site contamination
Alabama Steel Mill	Cs-137 0.01-.05 Ci	$50,000-$500,000	Accident: 1985 Cleanup: 1985-1986 Completed: Unknown	Alabama	Isotope gauge mixed with scrap feed. Final cost depends on disposal of waste.
Bank of Wisconsin, Universal Foundry	Cs-137 0.5 Ci	$4,000	Accident: 1985 Cleanup: 1985 Completed: Yes	Wisconsin	No details on accident. Licensee bankrupt and facility abandoned.
California Steel Mill	Cs-137 1.5 Ci	$1,000,000	Accident: 1985 Cleanup: 1985 Completed: Yes	California	Isotope gauge mixed with scrap feed.
Texas Time	Tritium 1000 Ci	$15,000-$20,000	Accident: 1983-1984 Cleanup: 1985 Completed: Yes	Arlington, Texas	Contamination from abandoned tritium watch factory. Costs incurred by licensee and building owner.
Automation Industries, Inc.	Ir-192	Greater than $2,000[b]	Accident: 1984 Cleanup: 1984 Completed: Unknown	Phoenixville, Pennsylvania	Contamination of facility during waste transfer.
Eberline Corp.	Am-241 0.089 Ci	$90,000[a]	Accident: 1984 Cleanup: 1984 Completed: Yes	New Mexico	No details on incident.
Owen Electric Steel Company	Cs-137 1 Ci	$450,000[a]	Accident: 1984 Cleanup: 1984 Completed: Yes	South Carolina	Melting of level gauge with sealed source Cs-137.

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TABLE B.2. (contd)

Case	Radionuclide and Activity Released (Ci)	Estimated Cleanup Cost	Dates	Location	Notes
Boeing	Po-210	Unknown	Accident: 1983 Cleanup: 1983 Completed: Yes	Wichita, Kansas	Leaking ionizing air nozzle. (Company unwilling to provide dollar figure for cleanup costs).
Shellwell Services, Inc.	Cs-137 20 Ci	$600,000[a]	Accident: 1983 Cleanup: 1983 Completed: Yes	Ohio	Well logging. Rupture of sealed source capsule, contamination of residences, public places, personnel. Shellwell's insurance company paid $373,174 for cleanup.
Professional Logging Service	Cs-137 0.125 Ci	$40,000[a]	Accident: 1982 Cleanup: 1983 Completed: Yes	Kentucky	Well logger drilled into Cs-137 source attempting to dislodge it from logging tool. Contamination of truck, house, driveway. Company paid for cleanup.
Auburn Steel Company	Co-60 25 Ci	$2,200,000[a]	Accident: 1983 Cleanup: 1983 Completed: Yes	Auburn, New York	Cobalt 60 contamination of metals product facility. Auburn Steel applied for Superfund monies to defray decontamination costs; application denied. (Company not a licensee).
Cities Service Company	Ra-226	$250,000-$300,000	Accident: 1956-1964 Cleanup: 1983 Completed: Yes	Kansas	Contaminated water from oil field recovery operation, precipitated filtered out into the media used as filter.
Western Nuclear, Inc.	Uranium Oxide 0.013 Ci[c]	$9,500[a]	Accident: 1982 Cleanup: 1982 Completed: Yes	Wellpinit, Washington	Tank rupture, ground contamination.
Dresser Industries	Cs-137 0.005 Ci	$3,000[a]	Accident: 1982 Cleanup: 1982 Completed: Yes	Alice, Texas	No details on incident
Consolidated Coal Company	Am-241 0.25 Ci	$1,000,000	Accident: 1982 Cleanup: 1982 Completed: Yes	Library, Pennsylvania	Well logging operation. Eleven locations contaminated when sealed source ruptured.
Allied Nuclear, Inc.	Co-60 0.003 Ci	$75,000[a]	Accident: 1981-1982 Cleanup: 1982 Completed: Yes	Washington	Soil/facility contamination at two locations from improper waste storage/disposal.

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TABLE B.2. (contd)

Case	Radionuclide and Activity Released (Ci)	Estimated Cleanup Cost	Dates		Location	Notes
Rochester Museum and Science Center	Ra 0.05 Ci	$3,027[a]	Accident: Cleanup: Completed:	1981 1981 Yes	Rochester, New York	Contamination of exhibit storage areas in basement resulting from broken medical radium source. (Museum not a licensee).
Kirk Dial and Crystal Company	Ra-226 0.000001 Ci	$500[a]	Accident: Discovered: Cleanup: Completed:	1932 1968 1981 Yes	Washington	Facility contamination.
Kerr-McGee	Th	Unknown	Accident: Cleanup: Completed:	1930s, 1940s 1953-1964 1980s No	West Chicago, Illinois	At least 100,000 pounds of tailings waste from discontinued thorium mill operation located in populated suburban area. Contaminated soil from site used as landfill in 1947-48 in various locations, including park. Kerr-McGee has paid for some cleanup work, such as dismantling of decontaminated buildings. In 1979, Kerr-McGee estimated thorough cleanup would cost between $5.4 and $63 million depending on cleanup option selected.
Coastal Radiation Services	Cs-137 100 mCi range	Unknown	Accident: Cleanup: Completed:	1979 1979 Yes	Sunshine, Louisiana	Soil contamination. Costs included at least one-man year of effort, including state time. State reserves right to reopen case.
Aircraft Instrument Development	Ra 226	Unknown	Accident: Discovery: Cleanup: Completed:	Pre 1979 1979 1979 Unknown	Kansas	Contamination of working areas throughout aircraft instrument repair shop. Company is in litigation, won't provide cleanup cost data.
Westinghouse Electric Corporation	Residual Contamination	$31,500	Accident: Discovery: Cleanup: Completed:	1942-43 1976 1976, 1979-1980 Yes	Bloomfield, New Jersey	Residual contamination of deactivated uranium production facility. Cost is for decontamination.
Century Geophysical/ Anaconda	Am-241 1 Ci	$140,000[a]	Accident: Cleanup: Completed:	1979 1979 Yes	Texas	Rupture of well logging source. Paid by Anaconda since well logger could not afford to pay.

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TABLE B.2. (contd)

Case	Radionuclide and Activity Released (Ci)	Estimated Cleanup Cost	Dates	Location	Notes
United Nuclear	Th-230 Ra-226	Unknown	Accident: 1979 Cleanup: 1979 Completed: Yes	Churchrock, New Mexico	Failure of tailings dam impoundment. Release of 1100 tons of tailings solids and 100 million gallons of tailings solution down dry creek bed. United Nuclear paid for removal of contaminated soil. Cleanup costs unknown but substantial; New Mexico also major participant in cleanup.
Lucky McMine	Unspecified	$316-$3,160[(b)]	Accident: 1972	Denver, Colorado	No details on incident.
U.S. Radium Corporation	Tritiated water	$3,160-[(b)] $31,600	Accident: 1972	Bloomsburg, Pennsylvania	Flood damage.
Medical Facility	Ra-226	$50,000	Accident: 1966 Cleanup: 1966 Completed: Yes	Charlotte, North Carolina	Rupture of Ra-226 nasal applicator. Contamination of facility. North Carolina may have paid $14,000 of total cleanup costs, source contacted was not certain.
General Electric	Uranium Solution	$3,160- $31,600[(b)]	Accident: 1966	Vallecitos, California	Estimated 420 lb of uranium solution were lost through tank overflow.
General Electric	UF_6	$316[(b)] or less	Accident: 1966	Vallecitos, California	UF_6 gas release from cracked valve.
Union Carbide	Uranium Ore	$316-$3,160[(b)]	Accident: 1963	Palisade, Colorado	Twenty-seven tons of uranium ore concentrate dumped into Colorado River.
General Electric	Radioactive Liquid	$316- $3,160[(b)]	Accident: 1959	Vallecitos, California	Radioactive liquid leaked from a cask while being transferred.
New England	I-125	Not given	Not given	Not given	Losses from scrubbing trap caused release to exceed limits.

(a) These cost estimates are taken from Table c.1 of Ostmeyer.
(b) Cost estimates from NRC's Nonreactor Event Report (NRER) Data base, "Fuelcycle" and "Omitcycle" sections of Database for Radiation Events in Commercial Nuclear Fuel Cycle, 1950-1978.
(c) Assumed specific activity 3.6×10^{-4} Ci/Kg. See footnote (a) source.

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TABLE B.3. Incidents Where Payer of Cleanup Costs is Unclear

Case	Radionuclide and Activity Released (Ci)	Estimated Cleanup Cost	Dates	Location	Notes
Delta Airlines Contamination Incident	Mo-99	Unknown	Accident: 1971 Cleanup: 1972 Completed: Yes	New York; Houston, Texas	Leakage of liquid caused by improper packing on passenger airline. Cargo hold and luggage contaminated.

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TABLE B.4. Incidents Where Cleanup Action Has Not Been Initiated

Case	Radionuclide and Activity Released (Ci)	Estimated Cleanup Cost	Dates	Location	Notes
Advanced Medical Systems	Co-60 300,000 Ci	$750,000-$1,000,000	Accident: 1985	Ohio	No details on accident. Active licensee, incurring large losses. Ongoing case.
Cesspool Waste	Co-60 0.04 Ci	$100,000[a]	Discovery: 1983	New York	Man who owned cesspool cleaning service used waste containing Co-60 from cesspool truck as fertilizer. Value of property less than cleanup cost. Owner (non-licensee) cannot afford cleanup.
Pesses Company	Th	Unknown	Accident: 1970s	Pulaski, Pennsylvania	Contamination of facility from processing thorium and other metals. Company went bankrupt in 1984, bank (non-licensee) holds mortgage to facility. Responsibility for cleanup unclear.
Shot Optical	Th	Unknown	Accident: Late 1960s, 1970s	Pennsylvania	Active licensee. Contaminated waste generated from a manufacturing process used to tint glass. Cleanup cost estimated by NRC source to be relatively low.
Molycorp	Th	Unknown	Accident: 1970s	York, Pennsylvania	Large volume, low activity waste. Former rare earth processing operation. Molycorp will probable pay for cleanup. Cleanup estimated to be expensive by NRC source.
Molycorp	Th	Unknown	Accident: 1970s	Washington, Pennsylvania	Large volume, low activity waste. Former rare earth processing operation. Molycorp will probably pay for cleanup according to NRC source.
U.S. Radium	Sr-90 Ra	Tens of millions $	Accident: 1950s, 1960s	Berwick, Pennsylvania	Large volume of low concentration waste burial on-site between facility and Susquehanna River. Responsibility for cleanup unclear.

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TABLE B.4. (contd)

Case	Radionuclide and Activity Released (Ci)	Estimated Cleanup Cost	Dates		Location	Notes
Kelekette Co.	Ra-226	Unknown	Accident: Cleanup:	1950s 1950s (initial)	Cincinnati, Ohio	Contaminated building in downtown Cincinnati. Initial cleanup conducted in 1950s, but not considered sufficient by current standards. Kelekette is presently bankrupt. Request for Superfund aid denied.
Sweeney Mining & Milling	U,Th (ore dust and tailings)	Unknown	Accident:	1940s to present	Colorado	Uranium and thorium ore-dust tailings pile as result of ore processing operations, and contamination of adjacent property.
U.S. Radium	Ra	Unknown	Accident:	1920s 1930s	Orange, New Jersey	Contaminated waste buried in a number of areas, homes later built over disposal areas. DOE funded pilot study of 6-9 homes. Litigation involved.
Stepan Chemical	U Th Ra	Unknown	Accident:	1916-1956	Wayne, New Jersey	Rare earth/ore processing operation. Residential homes and highway built over contaminated disposal areas. Cost of decontaminating residential properties unknown.
Denver Radium Site	Ra	Preliminary Estimates: $807,700-$1,584,200	Accident:	1913-1917	Denver, Colorado	Forty-four properties contaminated with low level radioactive residues left from radium processing. Superfund will pay for cleanup.

(a) These cost estimates are taken from Table c.1 of Ostmeyer.

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TABLE B.5. Cleanup Costs by Year,[a] ($1985)

	1979	1980	1981	1982	1983	1984	1985	1986
Cleanup Cost Paid by Licensee of Insurance Carrier								
Total Costs	$240,000		$4,000	$1,186,000	$3,302,000	$558,000	$1,297,000	$4,041,000
Number of Incidents	2		2	4	4	3	4	4
Cleanup Costs Paid by Superfund or State								
Total Costs	$910,000			$1,517,000			$4,135,000	$1,372,000
Number of Incidents	1			2			4	1

(a) The following assumptions apply to this table: 1) cost estimates and number of incidents are from Table B.1 and Table B.2; 2) some cost estimates and incidents from Tables B.1 and B.2 are not included here (for reasons see text); 3) cost estimates are both for completed and ongoing cleanup activities.

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TABLE B.6. Breakdown of Cleanup Costs by Payer, 1979 to 1986

Payer	Cleanup Costs ($1985)	Average Cost per Incident ($1985)
Licensee/Insurance Carrier, Superfund/State Agency	$18,562,000	$599,000
Licensee/Insurance Carrier	$10,628,000(b)	$462,000
Superfund/State	$7,934,000(c)	$992,000
Superfund	$2,077,000	$415,000
State	$5,857,000	$1,952,000

(a) For assumptions underlying these estimates please refer to footnote (a) of Table B.5 and to text.
(b) This total excludes seven incidents from Table B.2. The six entries marked with footnote (b) and which have cost range estimates are omitted because it is unclear whether these estimates are exclusively for cleanup, and because the ranges are too wide. A seventh entry, North Carolina Medical Facility, is omitted because it falls outside the 1979 to 1986 time period.
(c) This total excludes the Grace Properties case because the cleanup was funded by a special Congressional appropriation.

It should be noted that eight incidents with cost estimates that appear in Tables B.1 and B.2 are not included in the entries for Tables B.5 and B.6. Six entries from Table B.2, footnoted with (b), are omitted because the source from which they were taken does not specify what costs are represented. In addition, the estimates are presented in wide ranges in the original source, so it is difficult to even approximate what the actual cost was. Another Table B.2 entry for 1966, Medical Facility, was omitted because cleanup occurred substantially earlier than the 1979-1986 period so the costs are not likely to be representative of current cleanup conditions. Finally, the Grace Properties incident from Table B.1 was omitted because the source of the cleanup funds was unique--i.e., Congress--and because the cost was so much greater than any other incident in the tables, again reflecting an unrepresentative set of cleanup circumstances.

Information on materials licensee incidents and cleanup costs was gathered from several sources (Table B.7). One source was NRC databases on nonreactor incidents and descriptions of incidents in Agreement States. A second source was the results of a letter dated February 2, 1986 from the NRC Office of State Programs to Agreement States and to the NRC regional offices requesting that they provide information on licensees "who have experienced problems with availability of funds for clean up of contaminated facilities either as a result of normal operations or accidental or unexpected releases of radioactive

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TABLE B.7. Information Sources for Accidents Involving Nuclear Materials Licensees

1. Letter comment from EPA to NRC on the ANPRM. The comment provides brief summaries of 15 damage incidents caused by sudden occurrences at hazardous waste management facilities.

2. Unpublished accident histories generated by NMSS, September 1986.

3. Responses from March 12, 1986 NRC request to NRC Regional Offices and Agreement States regarding instances where availability of cleanup funds for accidental or unexpected releases of radioactive material has been a problem. States with radioactive release incidents responding to the information request were: Arizona, Colorado, Florida, Georgia, Kentucky. Louisiana, Kansas, Mississippi, New York, North Carolina, South Carolina, Texas, Washington.

4. NRC Office for Analysis and Evaluation of Operational Data, Nonreactor Event Report (NRER) Database.

5. Argonne National Laboratory, Data Base for Radiation Events in the Commercial Nuclear Fuel Cycle, 1950-1978, ("FUELCYCLE" and "OMITCYCLE" portions of Data Base), NUREG/CR-2429.

6. A. W. Grella, A Review of Five Years' Accident Experience in the U.S.A. Involving Nuclear Transportation (1971-1975), Office of Hazardous Material Operations, U.S. Department of Transportation, IAEA-SR10/5, August 1976.

7. Joel O. Lubenau and Donald A. Nussbaumer, Radioactive Contamination of Manufactured Products, NRC Office of State Programs, presented at the Annual Health Physics Society Meeting, July 1986.

8. FY85 Safety and Health Highlights, U.S. Department of Energy, Office of Environment Safety and Health.

9. Telephone calls to NRC Regional Offices and State Radiation Agencies.

materials." The Agreement States that responded and had at least one licensee incident to report were: Arizona, Colorado, Florida, Georgia, Kansas, Kentucky, Louisiana, Mississippi, New York, North Carolina, South Carolina, Texas, and Washington. A third source of information on materials licensee incidents consisted of telephone conversations with regional office and state radiological agency staff. These conversations added information on incidents that were incompletely described in other sources and also brought previously unknown incidents to the attention of the authors. Another source of information was Ostmeyer, especially Table C.1. This source was valuable for its information on the costs of cleanup. All cost figures from Ostmeyer appearing in Tables B.1 and B.2 of this appendix are footnoted "(a)."

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A number of caveats should be kept in mind while examining the tables in this appendix. First, the information contained in the tables should not be considered as a comprehensive record of all known materials licensee incidents involving accidental release of radioactive material. Tables B.1 through B.4 summarize the information gathered from the different sources, but do not purport to be an exhaustive listing of incidents. Second, the cost figures are frequently estimates of the costs of cleanup, not the actual recorded costs. In addition, it is often unclear whether the costs represent decontamination exclusively or also include other expenses. Time and resources did not permit a careful verification of each incident's cleanup costs. An exception is the cost figures from the Ostmeyer report. These costs were verified with a high level of confidence by the report authors, and reflect reasonably accurate costs of decontamination, packaging, transportation and disposal.

A third caveat is that even the carefully verified cleanup costs from Ostmeyer may not be good predictors of the cleanup costs of future accidents, since the standards for decontamination can become more stringent with time, and more stringent standards can result in costlier cleanups. This point should be kept in mind as well when comparing recent cleanup efforts with those in the 1960s or earlier. Fourth, when the licensee or insurance carrier incurred the cleanup cost and a dollar estimate is given, this figure usually does not include the cost that relevant state or federal agencies incurred to monitor and supervise the cleanup operation. This omission tends to understate the total cost of the cleanup. Fifth, radiological accidents involving an ICC-licensed trucking firm are not included in the tables. Interstate for-hire trucking firms are already required under the Motor Carrier Act of 1980 to have minimum levels of financial responsibility for environmental restoration and are outside the scope of the ANPRM (See Section 3.2.3). Similarly, incidents involving publicly owned facilities, including those operated by DOE and its contractors, are omitted because this class of licensees is not within the scope of the ANPRM.

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APPENDIX C

CLASSIFICATION OF LICENSES AND LICENSEES

APPENDIX C

CLASSIFICATION OF LICENSES AND LICENSEES

This appendix describes the data sets and procedures employed to estimate the total number of NRC and Agreement State materials licensees and to allocate them to appropriate risk-based categories by annual sales, licensed quantity of radioactive material, and type of business. The data sets used to make the allocation are discussed in Section C.1. The procedures used and the results are discussed in Sections C.2-C.4. Allocating licensees to the various categories was necessary to estimate the economic impact of proposed financial assurance requirements on radioactive materials licensees. It was necessary to divide licensees into categories representing risk factors (which determine the amount of assurance required) and size and type of business in which the licensees were engaged (which determine impact).

The license files of the NRC and the various Agreement States organize the licensees by functional program codes related to the type of activity, type of material, and amount of material. Some economic data for NRC licensees are available; however, no such data are available for Agreement State licensees. Even the exact count of licensees is uncertain, in part because about 20% of all licensees hold multiple licenses and because some licensees cover multiple activities in several states under a single license.

C.1 DATA SETS COVERING MATERIALS LICENSEES

For this report we used three data sets to estimate numbers of materials licensees: 1) the NRC DRR data set, 2) the NRC LMS data set, and 3) survey data collected by the Conference of Radiation Control Program Directors, Inc. (CRCPD).

C.1.1 NRC Division of Rules and Records

In the summer of 1983, NRC's Division of Rules and Records (DRR) surveyed approximately 7,000 NRC materials licensees, who held approximately 9,000 licenses. The survey was conducted using two questionnaires--the first was sent to 370 industrial radiographers in April, 1983, and the second was sent to about 6,600 remaining materials licensees in July, 1983. The overall response rate was 83%. The DRR data set developed from the survey responses includes information on economic size (sales and number of employees), and type of activity for 6,166 licensees. Geographical location data are available for 5,292 of these licensees. Of the 6,166 responses, 210 appear to be distribution licensees who must also hold another license for possession of radioactive material. To avoid double-counting, these licensees were excluded for this report, bringing the number of responses to 5,956.

There are several features of the DRR data set that complicate its interpretation. The first problem concerns multiple-license licensees. In order to avoid sending duplicate questionnaires to those licensees holding multiple licenses, an attempt was made by DRR to identify each license number and/or department/division at the top of each questionnaire. Where one licensee held many licenses, there was a special envelope prepared to hold the appropriate number of questionnaires to correspond with the number of licenses held at that address. In coding the results, DRR staff indicate that a single licensee holding multiple licenses in a single NRC program code appeared only once; however, if the licensee held licenses under several program codes, the licensee appeared in the data set under each code where he held a license.[a] Thus, there are an undetermined number of duplicate listings. In preparing this report we have chosen to assume that these duplicate listings are randomly distributed and do not affect the estimated distribution of the economic characteristics of licensees.[b]

The second problem concerns geographic distribution. All 50 states are listed on the DRR data set as containing some NRC licensees. Licenses in the 26 Agreement States presumably should have been issued only by a state agency.[c] We believe the discrepancy occurs for one or more of several possible reasons: 1) geographic miscoding of some licensees; 2) activities such as well logging and leak testing services that list a home office in one state and conduct field activities in several other states; 3) licenses originally issued by NRC in a nonagreement State that subsequently have been taken along with a transfer of activity to an Agreement State; 4) noncomprehensive Agreement State licensing that results in some activities being licensed by the state and others by the NRC. DRR staff have been unable to confirm or reject any of these hypotheses; however, for purposes of this report, we have assumed that the geographic coding in the DRR data set is accurate.

A final problem of interpreting the DRR data set is that the activity data were collected according to the approximately 50 NRC program codes that existed in the summer of 1983. In the fall of 1983 the program codes were revised, with some of the larger codes divided into a number of codes (e.g., 03120 was divided into 03120,03121,03122,03123, and 03124). The revision approximately doubled the number of program codes. To some extent, this revision limits our ability to classify and compare DRR data with data collected under the new program codes. The program code classifications adopted for this report are

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(a) Personal communication with Sara Wigginton, NRC Division of Rules and Records, November 21, 1986.

(b) Sandia National Laboratory researchers have examined the Licensing Management System file of NRC licensees and determined that multiple license licensees were randomly distributed. Personal communication with Robert Ostmeyer, Sandia National Laboratory, December 15, 1986.

(c) At the time of the 1983 DRR Survey there were 26 Agreement States. Utah became an Agreement State on April 1, 1984 and Iowa on January 1, 1986. Illinois has applied to NRC to become the 29th Agreement State.

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shown in Table C.1. The five application/use classes shown in the table form the basis for NRC's risk-based sliding scale coverage (Table 1.2) used in this report.

Other than the problems of interpretation described above, the most significant difficulty with using the DRR data set is that it does not cover materials licenses issued by the Agreement States. Data on state licenses and licensees had to be obtained from other sources.

C.1.2 NRC Licensing Management System (LMS) Data Set

The NRC Licensing Management System (LMS) data base is designed to keep track of existing NRC radioactive materials licenses, particularly the amount (possession limit), type of material (e.g., Americium 243) and form (e.g., sealed source, thin foil, standard solution). This data base can thus be used to provide estimates of the number of NRC licenses and licensees by NRC program code (i.e., by type of material held and physical or chemical form) and by the amount of material held. The amount of material held is a rough proxy for relative cost of cleanup within any particular program code.[a] The LMS data

TABLE C.1. Classification of NRC Program Codes into Application/Use Classes

Application/Use Class	Post-1983 Program Codes Included
I. Research, Teaching and Diagnostic, Therapeutic	01100,01110,01120,02110,02120,02121, 02200,02201,02210,02220,02300,02400, 02410,03218,03610,03611,03612,03620, 03710,21240,21320,21360,22110,22111, 22160,22161,11210,11220
II. Measurement, Calibration Irradiation	03110,03111,03112,03113,03120,03121, 03122,03123,03124,03220,03221,03222, 03223,03224,03225,03310,03320,03510, 03511,03520,03521,22120,22130,22140, 22150,22151
III. Manufacturing and Distribution	02500,03211,03212,03213,03214,11200, 11230,11300,21325,22162,22170
IV. Processing and Storage	03231,03232,03233,03234,06100,23100, 23200,25110
V. Fuel Cycle	11100,11400,11500,11600,11700,11800, 21130,21135,21210,21215

(a) Ostmeyer, p. 5. Material form and the application the material is being used for also impact cleanup costs.

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base contains information on approximately 7900 active, primary (i.e., nondistribution) NRC licenses.[a] For the purposes of this report, the LMS data base has two significant shortcomings: 1) with a few exceptions, it contains no data on Agreement State licensees; and 2) it contains no economic data on the NRC licensees. It is thus necessary to combine LMS data with other information to determine the distribution of licensees by program code, economic size, and amount of held. This three-way classification is necessary to estimate the economic impact of financial assurance regulations on licensees, especially licensees classified as small businesses.

C.1.3 Radiation Control Programs Profile

The information used in this report concerning the distribution of Agreement State materials licensees by type of activity comes from a report prepared by CRCPD.[b] The CRCPD is composed of the radiation control program directors in each of the 50 states and the local program directors of Los Angeles and Orange Counties, California and New York City. The report data are from a 1984 survey of all 56 of the state and local radiation control program agencies and selected federal agencies, covering fiscal year 1984 (July 1, 1983 to June 30, 1984). Entities for which no data are available included the District of Columbia and Puerto Rico (which were not members of CRCPD in 1984), as well as New Hampshire and Connecticut (which did not return complete information).

As with the DRR data set, there are several features of the CRCPD Profile that complicate its application for this report. The first problem is that the data set covers licenses rather than licensees. Since about 20% of NRC licensees are known to hold more than one license, the CRCPD data set is believed to similarly double-count some licensees. The license data were, consequently, adjusted for this report in order to estimate the number of licensees.

The second problem is that the CRCPD data set includes state Naturally-Occurring or Accelerator-Produced Radioactive Materials (NARM) licenses in the reported data, but does not break them out separately. NARM is not regulated by NRC and is not covered by agreements between the NRC and Agreement States to regulate nuclear materials under Section 274b of the Atomic Energy Act. However, many states either register or license NARM. Since NARM licensees are not within the scope of the ANPRM, an attempt was made to exclude NARM licenses of Nonagreement States for this report. We assumed that the CRCPD data set over-counts the number of licenses to which the ANPRM might apply by a minimum of 2400 licenses (15%). This number is the total number of licenses (all assumed to be NARM licenses) issued by nonagreement States. The CRCPD data are not reported in a manner to enable the subtracting of Agreement State NARM licenses.

(a) Letter from R. M. Ostmeyer, SNL, to P. L. Hendrickson, PNL, November 28, 1986.

(b) CRCPD Profile.

The third problem with the CRCPD data set is that a significant proportion of Agreement State licenses are not reported by program code. These licenses had to be allocated appropriately to the various license categories.

Finally, there are no economic data available on licensees in the CRCPD data set. It was necessary to assume that the distribution of licensees by economic size was the same for the Agreement State licensees as for the NRC licensees in the same detailed activity category. While there is no practical way to confirm this hypothesis, there is some support for it in the fact that Agreement State and NRC licensees are distributed in approximately equal proportions across risk classes. This available evidence suggests that the overall distributions of NRC and Agreement State licensees may be similar.

C.2 ALLOCATION OF LICENSEES TO RISK-BASED CATEGORIES AND ANNUAL SALES SIZE CATEGORIES

This section covers the procedures followed to allocate NRC and Agreement State licensees to appropriate activity and sales size categories.

C.2.1 Allocation of NRC Licensees to Activity and Annual Sales Categories

The DRR data set was used to allocate NRC licensees to appropriate categories. The 5,956 usable responses to the DRR survey were first assumed to represent licensees in spite of the problems with double-counting of multiple-license licensees. The 5,956 responses were allocated to the application/use classes in Table 1.2 as shown in Table C.2. Next, within each activity category, the DRR responses were aggregated to one of four DRR size classes based on annual sales: $0M to $1M, $1M to $7M, $7M to $25M, and over $25M. The number of responses in each sales size class and activity category was added up to provide a matrix of initial estimates of the number of licensees in each application/use class for each size class. Finally, the resulting number of responses in each cell in the matrix was multiplied by 1.175 to reflect the ratio between total NRC licensees (about 7,000) and the number of usable responses to the DRR survey (5,956). Thus, nonrespondents were assumed to be distributed proportionally across all sales size and activity categories. No information was available on the nonrespondents. The number of NRC licensees by application/use class and sales size is shown in Table C.5.

C.2.2 Allocation of Agreement State Licensees to Activity and Size Categories

The CRCPD Profile survey data were used to allocate Agreement State licensees to activity and size categories.

The CRCPD Profile state license activity categories are allocated to NRC program categories in Table C.3. This allocation was performed by comparing and matching CRCPD Profile activity titles with NRC program code titles. The number of state licenses was then collected for each of the activity categories. Next, the licenses issued by nonagreement States and distribution licenses were subtracted from each CRCPD Profile program category to remove

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TABLE C.2. Classification of NRC Licensees into Application/Use Classes

Application/Use Class	Activity Categories in DRR Survey
I. Research, Teaching, Diagnostic, Therapeutic	I. Academic (Broad), Nuclear Laundries, Medical Institution (Broad and Other), Medical Private Practice, Eye Applicators, Nuclear Medical Vans, Teletherapy, Veterinary, Research and Development (Broad, Multiregion, Other), Civil Defense, Pacemaker (Institutional), In-Vitro Labs
II. Measurement, Calibration, Irradiation	II. Other Measuring Systems, Irradiators, Radiographers (Multiple and Fixed Locations), Well Logging, Leak Testing, Uranium Sources, Other SNM Sources, Plutonium Sources
III. Manufacturing and Distribution	III. Marketing (Broad and Other), Other Uranium (less than and more than 150 Kg), Other Uranium Uses, SNM (Unencapsulated and Other)
IV. Waste Processing and Storage	IV. Waste Disposal (Burial, Other)
V. Fuel Cycle	V. Uranium Mills, Solution Mines, Fuel Storage

NARM licenses and double-counted licenses in the corresponding activity category. This step reduced the total number of licenses from 14,945 (the total that the CRCPD Profile report records as issued) to 12,023 (approximately the number potentially affected by the ANPRM). This latter number may still represent an overcount of licenses affected by the ANPRM, since NARM licenses issued by Agreement States are not affected by the adjustment.

The number of state licenses by activity was next adjusted for the 1,266 Agreement State licenses for which no activity category was listed by the CRCPD Profile respondents. For allocating CRCPD Profile licensees of unspecified type to Table C.3 categories, we assumed that medical, academic, source material, and SNM licenses belonged in Category I (Research, Teaching, Diagnostic and Therapeutic), while unspecified industrial licenses most likely belonged in the measurement, calibration, and irradiation categories represented by Category II. A case can be made for placing some of the unallocated industrial licenses in Category III (manufacturing and distribution), but no information was available to do so.

TABLE C.3. Classification of Agreement State Licenses into Application/Use Classes

Application/Use Class	Activity Categories in CRCPD Profile
I. Research, Teaching Diagnostic, Therapeutic	I. Academic (Broad), Nuclear Laundries, Medical Institution (Broad and Other), Medical Private Practice (Group and Nongroup), Eye Applicators, Nuclear Medical Vans, Teletherapy, Veterinary, Research and Development (Broad, Other), Civil Defense, In-Vitro Testing Laboratories
II. Measurement, Calibration, Irradiation	II. Special Nuclear Material, Well Logging, Measuring Systems (Fixed and Portable Gauges, Other Measuring Systems), Leak Test Services, Radiographers (In-Plant and Field), Irradiators (Self-Contained and Pool-Type)
III. Manufacturing and Distribution	III. Manufacturing and Distribution (Broad, Nonbroad), Source Material, Nuclear Pharmacies
IV. Waste Processing and Storage	IV. Waste Services (Prepack and Repack)
V. Fuel Cycle	V. No licenses listed

Once all the Agreement State licenses were allocated to activity categories in Table C.3 it was next necessary to allocate them by size of firm. To do this we assumed that Agreement State licensees had the same sales size distribution within an activity category and type of business as the corresponding NRC licensees in the comparably activity category. Table C.4 shows the resulting distribution of Agreement State licenses among the NRC application/use classes by sales level. The percentage of licenses falling into each sales level is derived from the DRR data set for NRC licensees.

It was next necessary to adjust the CRCPD Profile data to determine the number of Agreement State licensees by activity and level of sales. We did this by dividing licenses by the factor 1.286, the ratio of total licenses to licensees in the DRR data set. The number of Agreement State licensees were added to the number of NRC licensees from the DRR survey to obtain the total number of materials licensees by application/use class and level of sales, as shown in Table C.5.

TABLE C.4. Classification of Agreement State Licenses by Application/Use Classes and Annual Sales[a]

Application/Use Class		Annual Sales (1983-1984) Up to $1M	$1M to $7M	$7M to $25M	Over $25M	Total
I. Research, Teaching, Diagnostic, Therapeutic						
	Number	2,131	541	1,037	1,620	5,329
	Percent	40.0%	10.1%	19.5%	30.4%	100.0%
II. Measurement, Calibration, Irradiation						
	Number	2,135	1,161	963	1,996	6,255
	Percent	34.1%	18.6%	15.4%	31.9%	100.0%
III. Manufacturing and Distribution						
	Number	92	86	66	169	413
	Percent	22.3%	20.8%	16.0%	40.9%	100.0%
IV. Waste Processing and Storage						
	Number	8	8	10	0	26
	Percent	30.8%	30.8%	38.4%	0.0%	100.0%
V. Fuel Cycle						
	Number	0	0	0	0	0
	Percent	0.0%	0.0%	0.0%	0.0%	0.0%
Total	Number	4,366	1,796	2,076	3,785	12,023
	Percent	36.3%	14.9%	17.3%	31.5%	100.0%

(a) Adjusted for licenses in unspecified categories.

C.3 ALLOCATION OF LICENSEES BY LICENSED QUANTITY OF RADIOACTIVE MATERIAL

Once the allocation of licensees by activity category and level of sales was completed, it was next necessary to estimate how many licensees were to be affected by each level of coverage in the tentative NRC risk-based sliding scale of financial assurance coverage (Table 1.2). To do this, we applied the percentages of licensees having various amounts of radionuclides from the distribution of licensees by application/use class and amount of material in the LMS database. Percentages were calculated for NRC licensees by SNL.[a] The same percentages were assumed to apply to both Agreement State and NRC licensees.[b] The resulting distribution of licensees is shown in Table C.6.

C.4 ALLOCATION OF LICENSEES BY TYPE OF BUSINESS

To estimate the impact of the proposed financial assurance requirements on the financial condition of the licensees, it was necessary to allocate the licensees to businesses for which financial data were available. This was done

(a) Letter from R. M. Ostmeyer, SNL, to P. L. Hendrickson, PNL, November 28, 1986.
(b) Letter from R. M. Ostmeyer, SNL, to Shirley Fortuna, Policy and Program Control Branch, NMSS, January 5, 1987.

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TABLE C.5. Estimated Number of Materials Licensees Affected by the ANPRM, by NRC Application/Use Classes and Annual Sales

Application/Use Class		Annual Sales (1983-1984) Up to $1M	$1M to $7M	$7M to $25M	Over $25M	Total
I.	Research, Teaching, Diagnostic Therapeutic					
	NRC	543	420	835	1,347	3,145
	Agreement State	1,657	421	806	1,260	4,144
	Total	2,200	841	1,641	2,607	7,289
II.	Measurement, Calibration, Irradiation					
	NRC	1,037	622	556	1,174	3,389
	Agreement State	1,660	903	749	1,552	4,864
	Total	2,697	1,525	1,305	2,726	8,253
III.	Manufacturing and Distribution					
	NRC	85	90	70	180	425
	Agreement State	72	67	51	131	321
	Total	157	157	121	311	746
IV.	Waste Processing and Storage					
	NRC	4	4	5	0	13
	Agreement State	6	6	8	0	20
	Total	10	10	13	0	33
V.	Fuel Cycle					
	NRC	4	8	3	13	28
	Agreement State	0	0	0	0	0
	Total	4	8	3	13	28
Totals						
	NRC	1,673	1,144	1,469	2,714	7,000
	Agreement State	3,395	1,397	1,614	2,943	9,349
Grand Total		5,068	2,541	3,083	5,657	16,349

by matching individual NRC program codes and descriptions to individual 4-digit statistics of income (SOI) minor industry codes and descriptions in the IRS 85 publication. Table C.7 shows how the individual codes and categories were matched. This matching of codes resulted in the distribution of licensees by business and level of annual sales shown in Table C.8. This distribution was used to calculate financial impacts on licensees as described in Section 5.

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TABLE C.6. Estimated Number of Licensees Affected by the ANPRM, by NRC Applications/Use Class, Amount of Material Held, and Annual Sales

Application/Use Class	Annual Sales (1983-1984) Up to $1M	$1M to $7M	$7M to $25M	Over $25M	Total	Percentage
I. Research, Teaching, Diagnostic Therapeutic						
a. Less than 0.1 curie	1,056	404	787	1,251	3,498	48.0%
b. 0.1 to 1 curie	337	129	251	399	1,116	15.3%
c. 1 to 10 curies	535	204	399	634	1,772	24.3%
d. 10 to 100 curies	112	43	84	133	372	5.1%
e. More than 100 curies	160	61	120	190	531	7.3%
Total	2,200	841	1,641	2,607	7,289	100.0%
II. Measurement, Calibration, Irradiation						
a. Less than 0.1 curie	1,357	767	656	1,371	4,151	50.3%
b. 0.1 to 1 curie	485	275	235	491	1,486	18.0%
c. 1 to 10 curies	356	201	172	360	1,089	13.2%
d. 10 to 100 curies	113	64	55	114	346	4.2%
e. More than 100 curies	386	218	187	390	1,181	14.3%
Total	2,697	1,525	1,305	2,726	8,253	100.0%
III. Manufacturing and Distribution						
a. Less than 0.1 curie	48	49	37	95	228	30.4%
b. 0.1 to 1 curie	34	34	26	68	162	21.7%
c. 1 to 10 curies	27	27	21	54	129	17.5%
d. 10 to 100 curies	34	34	26	67	161	21.7%
e. More than 100 curies	14	14	11	27	66	8.7%
Total	157	157	121	311	746	100.0%
IV. Waste Processing and Storage	10	10	13	0	33	100.0%
V. Fuel Cycle	4	8	3	13	28	100.0%
	5,068	2,541	3,083	5,657	16,349	

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TABLE C.7. Match of NRC Program Codes and Activity Categories with IRS Statistics of Income Codes and Categories

Activity Categories	NRC Program Code(s)	SOI Business Category	SOI Code(s)
I. Research, Teaching, Diagnostic Therapeutic:			
a. Academic	01100,01110,01120, 21310,21320	a. Educational Services	8200
b. Medical Institutions, Teletherapy, Pacemaker, Eye Applicators, Medical Vans	02110,02120,02121, 02210,02220,02300, 22160,22161	b. Hospitals	8060
c. Nuclear Laundries	03218	c. Other Business Services, Except Advertising	7389
d. Medical Private Practice, Veterinary Services	02200,02201, 02400	d. Offices of Physicians	8015
e. Research and Development	03610,03611,03612, 01120,03620,21240	e. Manufacturing	40
f. In Vitro Laboratories	02410	f. Medical Laboratories	8071
g. Civil Defense	03710	g. No equivalent	N/A
II. Measurement, Calibration, Irradiation:			
a. Other Measuring Systems, Irradiators	03120,03121,03122, 03123,03124,03510, 03511,03520,03521,	a. Manufacturing	40
b. Radiography, Instrument Calibration, Leak Testing, Special Nuclear Materials	03310,03320,03220, 03221,03222,03323, 03224,03225,22120, 22130,22140,22150, 22151	b. Other Business Services	7389
c. Well Logging	03110,03111,03112, 03113	c. Oil Field Services	1380
III. Manufacturing and Distribution			
a. Manufacturing and Distribution; Pacemakers; Special Nuclear Material	03211,03212,03213, 03214,22162,22170,	a. Scientific Instruments, Drug Manufacture	3815 2830
b. Nuclear Pharmacies	02500	b. Wholesale Trade: Drugs	5129
c. Source Material	11200,11230,11300	c. Glass Products Manufacture	3225
IV. Waste Processing and Storage			
a. Waste Disposal Services, Burial, Storage	03231,03232,03233, 03234,23200,06100	a. Other Business Services, Except Advertising	7389
V. Fuel Cycle			
a. Uranium Mines, Mills	11100,11400,11500, 11600,11700,11800, 21130,21210	a. Other Metal Mining	1098
b. Fuel Storage	23100	b. Electric Utility Services	4910

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TABLE C.8. Estimated Number of Licensees Affected by the ANPRM, by NRC Application/Use Class, Type of Business, and Annual Sales

Application/Use Class	SOI Code	Annual Sales (1983-1984) Up to $1M	$1M to $7M	$7M to $25M	Over $25M	Total
I. Research, Teaching, Diagnostic, Therapeutic:						
a. Educational Services	8200	11	5	29	100	145
b. Medical Institutions	8060	403	558	1,490	2,284	4,735
c. Business Services	7389	9	3	0	0	12
d. Medical Practice	8015	857	76	22	5	960
e. Research and Development	40	97	127	93	192	509
f. Laboratories	8071	710	40	1	1	752
g. Civil Defense	N/A	113	32	6	25	176
Total		2,200	841	1,641	2,607	7,289
II. Measurement, Calibration, Irradiation:						
a. Measurement, Irradiation	40	1,547	1,137	921	2,048	5,653
b. Calibration, Radiography and Leak Test Services	7389	660	161	333	532	1,686
c. Well Logging and Field	1380	490	227	51	146	914
Services		2,697	1,525	1,305	2,726	8,253
III. Manufacturing and Distribution:						
a. Scientific Instruments	3815	35	46	28	54	163
b. Pharmaceuticals	2830	35	45	28	52	160
c. Nuclear Pharmacies	5129	22	16	8	15	61
d. Glass & Other Source Material Manufacture	3225	65	50	57	190	362
Total		157	157	121	311	746
IV. Waste Processing and Storage: Business Services	7389	10	10	13	0	33
V. Fuel Cycle						
a. Uranium Mines and Mills	1098	4	8	3	8	23
b. Fuel Storage	4930	0	0	0	5	5
Total		4	8	3	13	28
Grand Total		5,068	2,541	3,083	5,657	16,349

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REFERENCE ABBREVIATIONS

Abbreviation	Reference
Centaur	John Birdsong, Centaur Associates Inc., Washington, D.C., An Economic Study of the Radionuclide Industry, NUREG/CR-2048, July 1981.
CRCPD Profile	Conference of Radiation Control Program Directors, Inc., Frankfort, Kentucky, Profile of Radiation Control Programs in the United States for Fiscal Year 1984.
DRR Survey	A survey of nuclear material licensees conducted by the NRC Division of Rules and Records in 1983.
EPA 1985	EPA Office of Solid Waste (WH-562), "Summary of Comments to 50FR33902 Liability Coverage," October 1985.
IRS 85	U.S. Internal Revenue Service, Statistics of Income Division, Source Book, Statistics of Income: Active Corporation Income Tax Returns, July 1982-June 1983, Publication 1053 (Rev. 3-85), March 1985.
NRC 1986	NRC Division of Rules and Records, "Active NRC Licenses in Each Region by Program Code," 1986.
Ostmeyer	Robert M. Ostmeyer, Sandia National Laboratories, Dawn J. Skinner, GRAM Inc., A Preliminary Evaluation of the Economic Risk for Cleanup of Nuclear Material Licensee Contamination Incidents, NUREG/CR-4825, SAND86-2108, March 1987.
Practising Law Institute	Techniques of Self-Insurance, Practising Law Institute Course Handbook No. 400, Publication No. A4-4170, New York, New York, October 1986.

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13 ABSTRACT (200 words or less)

The NRC is considering a possible rulemaking that would require certain materials licensees to demonstrate financial ability to clean up accidental releases of radioactive materials. The rulemaking would potentially affect approximately 16,350 NRC and Agreement State licensees. This report was prepared to provide background information and analysis for the potential rulemaking. Specific topics examined in the report include: 1) characteristics of potentially affected licensees, 2) the availability and cost of various financial assurance mechanisms, 3) the financial impacts to licensees (including licensees classified as small businesses) of providing $2M of assurance per licensee and a sliding amount of assurance tied to risk, 4) the cost of administering a financial assurance rule, and 5) overall benefits and costs. Tabular information on past material licensee accidents and cleanup efforts is also included. The financial assurance mechanism that appears to be most suitable for providing the desired financial assurance is one or more newly-formed captive insurance companies. Potential benefits of the rulemaking include reduced need for taxpayer-funded cleanup of accidental releases, and reduced administrative time to secure such funds, and the possibility of more rapid cleanup with correspondingly reduced occupational and public exposure to radioactive materials.

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